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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

GEOLOGICAL SURVEY OF GREAT BRITAIN

THE COUNTRY AROUND CIRENCESTER

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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

MEMOIRS OF THE GEOLOGICAL SURVEY ENGLAND AND WALES

EXPLANATION OF SHEET 235

The Country around Cirencester

By Linsdall Richardson, F.R.S.E.

With contributions by

Professor J. A. Hanley, A.R.C.S., Ph.D.

and

H. G. Dines, A.R.S.M.

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PREFACE

The greater part of this district was shown on the Old Series Geological Map, Sheet 44, surveyed by E. Hull and published in 1856. A descriptive memoir by E. Hull appeared in 1857. Mr. L. Richardson, the author of the present volume, has long been acquainted with the local geology, and has made a special investigation of the Great Oolite and Forest Marble for the purpose of this memoir. He desires to place on record his appreciation of Hull's work, and follows him in being of the opinion that it is best to represent all the rocks between the Great Oolite White Limestone and the Cornbrash by one colour on the map.

Since the Royal Agricultural College is situated within the area, and the district is essentially agricultural, it was thought desirable that the memoir should contain an authoritative account of the soils and their relationship to the types of farming practised, and also a sketch-map showing the distribution of the clay, limestone and superficial deposits in the vicinity of the college. Professor J. A. Hanley, A.R.C.S., Ph.D., formerly Principal of the Royal Agricultural College, Cirencester, and Professor of Agriculture at the University of Bristol (1927-31) and now Professor of Agricultural and Rural Economy at Armstrong College, Newcastle-upon-Tyne, contributed the section on agriculture ; Mr. H. G. Dines, who surveyed the superficial deposits throughout the whole district, has prepared the sketch-map.

The frontispiece is taken from a photograph placed at the disposal of the Geological Survey by Mr. E. C. Sewell of Cirencester ; the other photographs were taken, under Mr. Richardson's direction, by Dr. F. B. A. Welch.

The volume has been prepared for the press by Dr. Bernard Smith and Mr. C. P. Chatwin.

JOHN S. FLETT,
Director.

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31st August, 1932.

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CHAPTER I

INTRODUCTION

Area and Location

The Geological Map Sheet 235, on the one-inch scale, represents an area of 216 square miles and embraces a considerable part of East Gloucestershire and a long narrow strip of western Oxfordshire. There are three country towns in the district: Cirencester, toward the south-west corner, a market town and residential centre noted for its Roman remains, fine church and market place, and the extensive Cirencester Park; Fairford, about eight miles east of Cirencester, far-famed for its church's stained-glass windows; and Northleach, about nine miles north-east by north from Cirencester, a typical Cotteswold town dominated by a church that is a monument to the generosity of the wool-staplers of a bygone age. There is a host of villages: in the limestone country most of the larger ones are situated in the valleys alongside the rivers; those on the uplands are mostly small, widely-separated, and clearly owe their locations to the occurrence of springs in country in which reliable springs of adequate volume are few and mostly far apart.

The district is not well served by railways. The Cheltenham-Southampton line (G.W.R., formerly the Midland and South Western Junction Railway) climbs the Cotteswolds by way of the Chelt valley and the Dowdeswell tunnel, runs from Andoversford southwards to Cirencester, and opens up a strip of country from north to south down the western half of the district. The East Gloucestershire Branch of the G.W.R. from Oxford, *via* Witney, terminates at Fairford, and serves a small area in the south-east; but a large tract traversed by the Ermin Street, and a far larger tract toward the centre of which is situated Aldsworth, is difficult of access from railway stations.

The district with which this memoir deals is essentially agricultural. It must be added, however, that it is to a considerable extent residential: in addition to numerous fine mansions and manor houses, there are many smaller houses and cottages occupied by those who have sought retirement in the country.

Only a very short portion of the Cotteswold escarpment, namely that along part of the south side of the Chelt valley, comes within the present district—in the north-west corner. Consequently, this district is lacking in the extensive views westwards over the Severn valley into Wales which constitute one of the principal attractions of the Cotteswold country. As a recompense, however, it contains a larger tract than elsewhere in the hill country that may be regarded as typically Cotteswoldian. 'Open' undulating country, with a prevalent southerly to south-easterly inclination, is furrowed by valleys containing Thames-ward flowing streams and numerous tributary 'dry' valleys. It is partly down land and partly arable; studded with conspicuous clumps of trees and locally lined with long plantations; partitioned by 'dry' grey stone walls, and dotted with isolated farms and lonely villages built of local stone and mostly roofed with local 'slates.' No sooner, however, is the brash-land of the true Cotteswold country left and the Oxford Clay tract entered upon than trees become more numerous and generally distributed and hedges separate the pastures.

The geology is of special interest, (1) for the clear evidence it contains of flexing along two anticlinal and two synclinal axes of consolidated Inferior Oolite rocks, removal of rock along and in the vicinity of the axes of uplift, marine planation, and perforation by annelids and boring molluscs of the rock sea-floor previous to the non-sequential superposition of the 'Top Beds' (*i.e.* the Upper Trigonia and Clypeus Grit) of the Inferior Oolite; (2) for the occurrence of numerous sections in the Great Oolite (especially in the White Limestone subdivision with its peculiar 'Dagham Stones'); and (3) for the presence of 'bournes.'

Physical Features

Relief.—The Cotteswold Hills are 57 miles long and extend from Meon Hill, six miles south by west of Stratford-on-Avon, to Lansdown Hill above Bath. They present steep faces to the Severn and Moreton valleys, but their limit between Witney and Bath is indefinite. S. S. Buckman, who made a large number of enquiries with a view to determining the extent of the hills,[1] had therefore to recommend the acceptance of an arbitrary boundary between Witney and Bath: "For the south-eastern boundary from Witney [to Easton Gray] I have taken roughly the limit of the Cornbrash, where it dips under Oxford Clay"[2]—where the 'dry' stone wall country gives place to the hedge-partitioned pastures. Buckman also divided the Cotteswolds into three parts[3]: (1) the North Cotteswolds, to the north of the Chelt valley and "the Oxford road from Andoversford as far as Little Barrington, where

[1] 'The Cotteswold Hills: A Geological Enquiry,' *Proc. Cotteswold Nat. F. C.*, vol. xiv, pt. 3, 1903, pp. 205-250 and pl. vii.
[2] *Idem*, p. 234.
[3] 'The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 389.

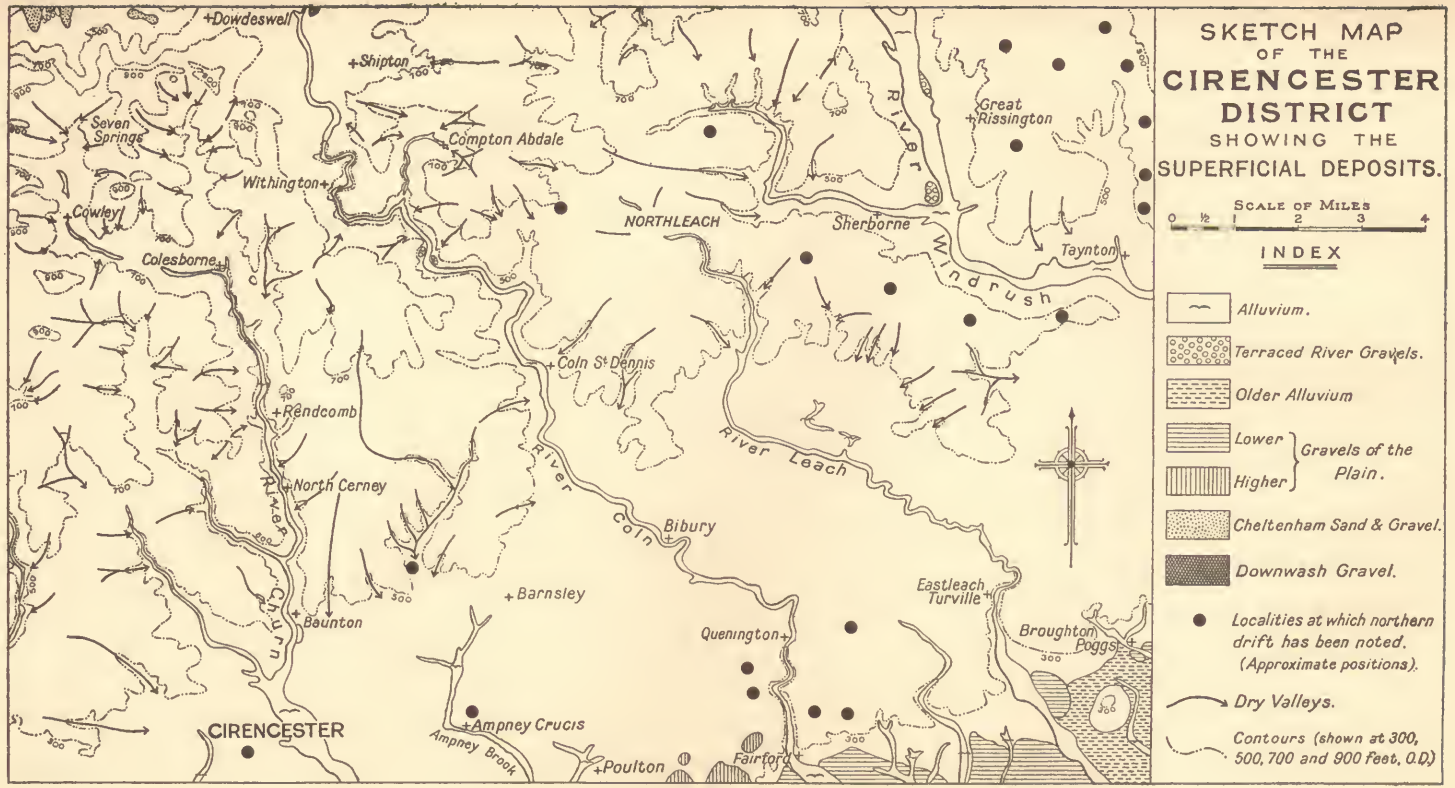

FIG. 1.—*Sketch-map of the Cirencester district.*

it [the division line] might turn into the valley of the Windrush"; (2) the Middle or Mid Cotteswolds, between the above-mentioned line of demarcation and the valley of the Frome "and the road from Chalford to Siddington, and then . . . along the line of the Cornbrash"; and (3) the South Cotteswolds. The district under consideration therefore is mainly in the Mid Cotteswolds.

Relatively low ground (lowest, 300 ft. O.D.) occurs in the north-western corner of the district in the Chelt valley, and toward the north-eastern portion (lowest, 391 ft. O.D.) in the Vale of Bourton. The hills overlooking the Chelt valley rise near Pegglesworth to 979 ft. above Ordnance Datum, and those overlooking the Vale of Bourton above Little Rissington to 751 ft. From the northern heights the ground declines; from 979 ft. above Ordnance Datum near Pegglesworth to 343 ft. at Cirencester, and from 751 ft. above Little Rissington to 250 ft. near Little Faringdon. The predominant slope of the country may be described as south-eastward. This inclined surface has been rendered undulating by the furrowing action of many rivers and streams.

Drainage.—The district is in the Thames Basin with the exception of two small areas in the Severn Basin, the first being about 4 square miles drained by the River Chelt in the north-west corner, and the second about $2\frac{1}{4}$ square miles along the western margin between the Ermin Street and Cirencester-Stroud road, which is drained by the River Frome.

The head-waters of the River Chelt are impounded below Dowdeswell in a reservoir belonging to the Cheltenham Corporation. At Charlton Kings a tributary of the Chelt, the Lilley Brook, steeply-graded, is working headwards into a wind-gap from the southern part of which issues as the Seven Springs (locally regarded as the source of the Thames[1]) the relatively gently graded River Churn—a Thames stream.

The portion of the Frome valley that comes in the district under consideration is deep and steep-sided and is sunken through Great Oolite, Fullers' Earth, and into the Inferior Oolite. Owing to the permeable nature of the rocks traversed by its course the flow of the river here rapidly responds to variations in water supply and water-table. The springs thrown out by the Fullers' Earth from the base of the Great Oolite rapidly part with their lime content, and locally, as in Henwood, form extensive deposits of 'puff stone' or tufa.[2]

The Thames streams all possess many features of interest. Taken in order from west to north-east the principal streams are the River Churn, the River Coln, the River Leach, and the River Windrush with its tributary the Sherborne Brook. Between the drainage-basins of the Churn and Coln is that of the interesting Ampney Brook that has its permanent source in Ampney Park; but a valley extends above the source for miles

[1] Phillips, J., 'The Geology of Oxford and the Valley of the Thames,' 1871, pp. 29, 30.
[2] Duncan, C. C., and L. Richardson, 'Hen Wood Petrifying Spring, Edgeworth,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1, 1924, pp. 55, 56.

and is dry except in winter, when Winterwell Spring in particular issues and is the principal contributor to a bourne that flows down the valley (Plate I). Between the drainage-basins of the Leach and Windrush is that of the Shill Brook.

The above-mentioned rivers and brooks have been recently described by the writer elsewhere.[1] It is not necessary to repeat the details here; but reference may be made to the Shill Brook, to river development, to meanders of the River Coln, and—later (p. 89)—to the dry valleys which are so attractive a feature of the district.

The Shill Brook, which in this district flows by way of Westwell and Holwell and eventually discharges into the Thames, rises in a spring (thrown out by marly layers in the White Limestone subdivision of the Great Oolite) in Rangehill Copse about three-quarters of a mile to the south of Windrush. A well-defined valley with watercourse runs from this source by way of Hill Barn, Hollow Barn, the third milestone from Burford on the Burford-Aldsworth road, Westwell and Holwell; but in spite of small springs (also thrown out by marly beds in the White Limestone) at Westwell, the watercourse is streamless for a considerable part of the year.

The district under consideration has received considerable attention at the hands of students of river development—especially Dr. T. S. Ellis, Prof. W. M. Davis and the late S. S. Buckman. Ellis remarked as long ago as 1882[2] that the direction of the rivers in the Severn valley and Cotteswold Hills was such as to suggest that at one time, before the Severn existed, rivers had flowed from north-west to south-east across the sites of the present Severn valley and Cotteswold Hills into a parent Thames. Davis visited the Sevenhampton and Withington areas in company with Buckman and the results of the visit found expression in Buckman's paper on 'The Development of Rivers, and Particularly the Genesis of the Severn.'[3] For a full statement of the theory of river development so far as this part of England is concerned, the reader is referred to this paper. In brief, it is that at one time the rivers flowed from north-west to south-east (as 'consequents') across a non-existent Seven valley and the Cotteswold Hills; that subsequently the River Severn, working headwards (*i.e.* northwards up the Severn valley), successively beheaded the consequents and initiated streams in the valleys of the beheaded consequents immediately to the east of the points ('elbows') of capture of their head-waters; and that the growth of the Severn and its tributaries on the left bank led to the initiation and subsequent retreat of the Cotteswold escarpment. In the present district, according to this theory, the directions of the Churn, Coln, and Leach indicate the general directions of

[1] 'Wells and Springs of Gloucestershire' (*Mem. Geol. Surv.*), 1930, pp. 39-43.
[2] 'On some Features in the Formation of the Severn Valley as seen near Gloucester,' *School of Science Phil. Soc.*, 1882.
[3] 'Natural Science,' 1899, pp. 273-289.

the original consequent streams of which they are relics. The Stroud Frome, however, is an obsequent (or anti-dip) stream developed by the Severn that has grown headwards—its north-and-south alignment in this district being probably connected with the Birdlip anticline which would cause Upper Lias clay to be elevated along the axis. The River Chelt is another obsequent stream developed by the Severn—in this case working eastwards into the Coln drainage-basin.

The valley of the Coln between Andoversford and Withington is excellent ground on which to study river-meanders from their initiation to their extinction—to the time when the neck is severed and a little ox-bow lake is formed.

The contours on the sides of the Coln valley between Andoversford and Withington indicate (as pointed out by Buckman[1]) that at one time a much larger river flowed down this valley—very different in size from the present Coln which is a good example of a ' misfit.'

Geological Formations

The following formations are distinguished on the colour-printed edition of Sheet 235 of the Geological Survey Map :—

Superficial	Alluvium	Recent and Pleistocene
	Terraced River Gravels	
	Older Alluvium	
	Lower Gravels of the Plain	
	Higher Gravels of the Plain	
	Downwash Gravels	
	Cheltenham Sand and Gravel	
Oxford Clay		Upper Jurassic
Cornbrash		Middle Jurassic
Forest Marble		
Great Oolite		
Fullers' Earth	Fullers' Earth (the local) and Upper Estuarine Clay	
	Chipping Norton Limestone	
	Roundhill Clay	
Inferior Oolite		
Upper Lias	Cotteswold Sands (trace)	Lower Jurassic
	Upper Lias clay	
Middle Lias	Marlstone	
	Sandy Beds	
Lower Lias		

Concealed Rocks

The Palaeozoic floor has not been reached by any boring in the district under consideration, but it was proved at five-eighths of a mile to the east (or $1\frac{5}{8}$ miles east of Westwell) near Burford Signet.

[1] *Proc. Cotteswold Nat. F. C.*, vol. xiii, pt. 3, 1901, pp. 175-190.

Burford Signet Boring

Made in 1875-77. North of the Shill Brook, west of the plantation to the west of Sturt Farm, and east of the bend in the road south of Signet (Sheet 236). Surface-level about 345 ft. above Ordnance Datum.

	Thickness Ft.	In.	Depth Ft.	In.
Great Oolite (boring commenced in about the middle of the White Limestone)	62	6	62	6
Inferior Oolite	27	8	90	2
Lias { Upper	81	6	171	8
Lias { Middle	98	1	269	9
Lias { Lower	447	4	717	1
Rhaetic	33	0	750	1
Keuper, Upper	433	11	1184	0
Carboniferous : Coal Measures ...	226	0	1410	0

H. B. Woodward[1] stated that there is a core of ' coal shale ' from a depth marked 1,174 ft. in the Warwick Museum, but a search for it has been unsuccessful.

[1] For a detailed record see H. B. Woodward, ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 304. Particulars have also been published by C. E. De Rance, *Rep. Brit. Assoc.* for 1878, p. 384 ; *Trans. Manchester Geol. Soc.*, vol. xiv, 1878, p. 437 ; and R. Etheridge, *Pop. Sci. Review*, ser. 2, vol. iii, 1879, p. 290 ; the details varying in each case.

CHAPTER II

LIAS

Lower Lias

The Lower Lias, the oldest formation in the district, occurs (1) in the north-western corner in a portion of the Chelt valley, and (2) in the north-eastern part of the area—(*a*) in the southern half of the Vale of Bourton, and (*b*) just showing, on the line of the Hazelford Brook in Taynton Bushes. Nowhere, however, is there a good exposure.

Just east of the district under consideration, at Burford Signet, the boring already noticed (p. 7) proved the thickness of the Lower Lias to be about 450 ft.; probably it thickens to the west.

Details

The Capricornus Zone (*sensu lato*), richly fossiliferous, was displayed in the railway-cutting west of Charlton Kings Station when the cutting was widened to receive the quarry railway (now dismantled) from the Leckhampton Hill quarries.

The now obliterated pit, locally known as 'Oulan's,' on the right bank of Lilley Brook and immediately east of the Cirencester road, was probably in the Capricornus Zone.[1]

Alongside Little Herbert's Lane, near its junction with Timbercombe Lane, is a small pit in higher beds. This pit was opened in 1883 to obtain loamy clay for use at the potteries near Leckhampton Station, but the clay proved unsuitable.[2]

Middle Lias

The Middle Lias consists of two subdivisions :—

> The Marlstone or Rock Bed; as a rule an impure blue-hearted limestone weathering brown : from about 15 ft. in the north-west to a few feet in the north-east; resting on
>
> Sandy Beds; yellow, grey and brown sandy shales with thin bands of calcareous sandstone and ferruginous nodules : from 100 ft. in the north-west to about 50 ft. in the north-east.

It occurs (1) in the north-west corner of the district where it crops out in the lower part of the hill slope on the south side of the Chelt valley, and (2) in the north-east part of the area—(*a*) on the margins

[1] Richardson, L., ' Memoir Explanatory of a Map of a Part of Cheltenham and Neighbourhood showing the Distribution of the Sand, Gravel and Clay,' *Proc. Cotteswold Nat. F. C.* vol. xviii, pt. 2, 1913, p. 127.

[2] *Idem*, p. 127; L. Richardson, 'A Handbook to the Geology of Cheltenham . . ,' 1904. p. 47.

of the southern half of the Vale of Bourton, and (*b*) on the floor of the Windrush valley in the neighbourhood of Taynton, and the valley of the Hazelford Brook and in the valleys of its tributaries.

Details

In the north-west corner of the district the outcrop of the Sandy Beds can be readily detected by the frequently wet ground at their base and the occurrence of gorse. They are best displayed in the old sunken trackway near Timbercombe, and the Marlstone is indifferently displayed above them in the sides and near the top of the trackway.[1]

In the north-eastern part of the district the Marlstone is exposed in the left bank of the River Windrush some 75 yds. north-north-west from the trackway-bridge near the ruined mill (Dodd's Mill) 1¼ miles E. 15° N. from Sherborne Church, where it is a hard brown slightly ferruginous and somewhat sandy limestone with 'nests' of *Lobothyris punctata* (J. Sowerby) and occasional specimens of *L. edwardsi* (Davidson).

Woodward remarked[2] that in this part of the district ".. . . the beds are rarely exposed, and no sections have been recorded. In company with Mr. W. Topley, I saw traces of the Rock-bed, with *Rhynchonella* [*Tetrarhynchia*] *tetrahedra*, north of Dodd's Mill, [south of Great] Rissington; but in this area, judging from the evidence of the Burford boring. . . and the absence of quarries, the Rock-bed is probably but a few feet in thickness; while the lower sandy shales of the Middle Lias may not exceed 50 feet."

Hull said[3]: "In tracing the Marlstone towards the south-east from Stow, we find its thickness becoming gradually less, arising rather from the gradual disappearance of the sandy strata below the rock-bed than from the thinning of the rock-bed itself. In the Tainton valleys, towards Tangley, the Marlstone is frequently composed almost entirely of highly ferruginous sandstone with Belemnites, its thickness varying from 10 to 20 feet. This is proved by the occurrence of blue clay of the Lower Lias in the bed of the brook."

Upper Lias

The Upper Lias is blue clay except for a few thin limestones at the base, occasional limestone nodules, and locally at the top sandy clays and sand.

Sands and sandy clays are to be seen in the cutting through which the Cirencester road passes (at the spot-level 720) two-fifths of a mile north from the Seven Springs (Coberley parish); in the third cutting from Andoversford on the line to Cirencester; in an opening on Charlton Kings Common near Daisy Bank; and were entered at the bottom of a well at Hartley Cottages on Leckhampton Hill. These deposits may be called Cotteswold Sands. Fossils obtained from the well indicate that the Sands are there of *variabilis* date. Scissum Beds succeed the Sands in the well and in the railway-cutting near Andoversford, and, unlike the Scissum Beds at Cooper's Hill, near Gloucester,[4] do not have any rolled fragments of Cephalopod Bed attached to or embedded in their basal stratum. Farther south, as, for example, in the neighbourhood of Wotton

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[1] Richardson, L., 'Memoir Explanatory of a Map of a Part of Cheltenham. . . .,' *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, p. 128.

[2] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iii, 1893, p. 219.

[3] 'The Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 21.

[4] Richardson, L., 'Excursion to Cranham and Cooper's Hill,' *Proc. Cotteswold Nat. F.C.*, vol. xxii, pt. 2, 1925, p. 81.

under Edge, the Upper Lias is mainly sand—in ascending sequence of *semipoliti, lilli,* and *variabilis* hemerae, capped with the Cephalopod Bed. As the Sands are followed to the north it is to be observed that they become replaced by clay from the base upwards. In the north-western part of the present district only the topmost portion of the Upper Lias remains sandy. Thus in the railway-cutting near Andoversford there is a considerable non-sequence between the Sands and Scissum Beds: deposits of *variabilis* (late)-*opaliniformis* hemerae (inclusive) are absent.

Hull mapped the sandy Scissum Beds as 'Midford [Cotteswold] Sands.' The boundary lines of the Sands have not been revised for the new map, so Cotteswold Sands appear thereon in the neighbourhood of Sherborne, but not farther eastward: it is probable that the deposit represented as such on the Old Series Map, Sheet 44, east of a line joining Clapton and (say) Farmington is wholly Scissum Beds.

Sands are absent from the Rissington district: therein Clypeus Grit (the top subdivision of the Inferior Oolite) rests non-sequentially on Upper Lias clay. Hull estimated the thickness of the Upper Lias to be 20 ft. at Taynton.

The approximate thicknesses and top and bottom altitudes of the Upper Lias at the localities specified below are as follows:—

	Charlton Kings Common, Cheltenham	Turkdean	Clapton	Little Rissington
Height above O.D. of top ...	685	?530	685	710
Approximate thickness ...	230	?	170	100
Height above O.D. of base ...	455	?	515	610

Details

When the well was deepened at Hartley Cottages, Leckhampton Hill (Sheet 234), in connexion with the improvement of the water supply to the City of Birmingham Sanatorium, Salterley Grange, some interesting particulars were obtained as to the age of the Upper Lias deposit on which the Inferior Oolite rests at this locality.[1] Unfortunately, the actual junction of the Oolite and Lias could not be investigated, but from rock dug out and the included fossils it was ascertained that the top part of the Upper Lias was sandy clay and rock of *variabilis* hemera and representative of a portion of the Cotteswold Sands of certain localities in the South Cotteswolds.

[1] Richardson, L., 'On Two Deep Well Sinkings at Leckhampton Hill, Cheltenham,' *Geol. Mag.*, 1910, pp. 101-104.

Hartley Cottages' Well, Leckhampton Hill

		Ft.	In.
Inferior Oolite	Clypeus and Upper Trigonia Grits and beds between the Upper Trigonia Grit and the local base of the formation	200	0
	[*Non-sequence*]		
Upper Lias	1. Hard, greyish-blue sandy micaceous clay ...	3	9
	2. Yellow ferruginous, micaceous, indurated sandy clay; *Nautilus*, *Belemnites* (phragmacones), *Gryphaeae*	1	0
	3. Greyish-blue clay similar to 1	6	4
	4. More arenaceous but otherwise similar clay ...	1	0
	5. Greyish-blue sandy rock; *Belemnites* (near to *B. tubularis* Young and Bird),[1] *Haugia grandis* S. Buckman,[1] *Haugia sp. indet.*, *Dactylioceras* cf. *holandrei* (d'Orbigny), *Thysanoceras sp.* (fragment : *? T. sublineatum* (Oppel)),[1] *Entolium demissum* (Phillips),[1] *Pleuromya sp.*	1	8
	(*Bottom of well at 226 ft. 1 in.: water ran away*)		
	6. Sandy clay...	11	9
	7. ' Very fine blue sand ' ... ... penetrated	23	3

Near ' Daisy Bank ', at the extreme western end of Charlton Common, there was, some twenty-five years ago, a small pit in somewhat slipped sandy clay (Cotteswold Sands) probably of *variabilis* date, which was opened to obtain ' sand ' for mixing with and so ' lightening ' the ' strong ' clay (Lower Lias) dug at The Cotswold Potteries, Leckhampton Station.

Between Mountains Knoll Wood and the Cirencester road (at a spot half a mile west of Vineyards Farm) a temporary excavation revealed Upper Lias (near its base) with crowds of small ammonites belonging to the genus *Dactylioceras*.

From the bed of the track some 350 yds. east of Vineyards Farm, Wistley Hill, a portion of the ammonite *Lillia lilli* was obtained by the writer from a hard bluish-black limestone-nodule embedded in the Upper Lias clay.[2]

From the drive of Dowdeswell Rectory a specimen of *Harpoceras* aff. *fellenbergi* (Hug), indicative of hemera *falciferi*, has been obtained (Reg. No., Z 3856).

In the cutting near Northfield Farm (the ' third cutting from Andoversford' of S. S. Buckman and the ' Cleveley Wood ' cutting of H. B. Woodward) on the line to Cirencester, Upper Lias deposits, which may be regarded as Cotteswold Sands, are displayed in the centre of a sharp little anticline flanked by Scissum Beds succeeded by Lower Limestone and typical Pea Grit. The damp clayey centre is now (1929) covered with grass. The section has been described by S. S. Buckman,[3] E. B. Wethered[4] and H. B. Woodward[5], the following record being based on their accounts.

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[1] These specimens are now in the Cheltenham Municipal Museum.

[2] Buckman, S. S., ' The Toarcian of Bredon Hill, and a Comparison with Deposits elsewhere,' *Quart. Journ. Geol. Soc.*, vol. lix, 1903, p. 449; L. Richardson, ' A Handbook to the Geology of Cheltenham. . . . ,' 1904, p. 60.

[3] ' The Sections exposed between Andoversford and Chedworth. . . ' *Proc. Cotteswold Nat. F. C.*, vol. x, 1892, p. 96.

[4] ' The Inferior Oolite of the Cotteswold Hills, with Special Reference to its Microscopical Structure,' *Quart. Journ. Geol. Soc.*, vol. xlvii, 1891, p. 551.

[5] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 126.

Third Cutting from Andoversford

		Thickness Ft.	In.
Pea Grit	1. Pisolite	—	—
Lower Limestone	2. Limestone in irregular beds mixed with marl	10	0
Scissum Beds	3. Limestone, yellow, sandy, in several beds; *Quadratirhynchia subdecorata* (Davidson), *Homoeorhynchia cynocephala* (Richard), *Lophrothyris withingtonensis* (S. Buckman), *Pholadomya fidicula* J. Sowerby, etc.	12	0
	4. Calcareous bed	0	10
	5. Sandy limestone; *Belemnites spp.* ...	1	2
	6. Crystalline limestone	0	6
	[*Non-sequence*: deposits of *opaliniformis* to ? (late) *variabilis* hemerae (inclusive) wanting]		
Cotteswold Sands	7. Brown and blue sands	2	0
	8. Clay	0	4
	9. Yellow ferruginous sand	0	6
	10. Bluish-grey clay with ferruginous streaks	5	0
	11. Yellow micaceous and ferruginous sands	4	0
	12. Rubbly ironstone layer	2	0
	13. Grey laminated clay and sand... ...	2	0

The cutting at Withington Station is in Upper Lias: according to H. B. Woodward through "about 30 feet of more or less micaceous clays, alternating with greenish-grey sands."

Hull recorded[1] that Upper Lias clay was worked for brick-making at Colesborne. The pit has been long overgrown but fragments of *Harpoceras elegans* (J. Sowerby) (Reg. No., Z 3831) and *Hildoceras hildense* (Young & Bird) (Reg. No., Z3833) obtained here date the clay as *bifrontis*.[2]

Upper Lias clay has also been dug for brick- and tile-making at the western end of Sherborne village, but the horizon is not known.[3]

[1] 'Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 24.

[2] Richardson, L., '. . . Excursion to Colesborne. . . .' *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 1, 1910, p. 20.

[3] Richardson, L., and R. J. Webb, 'Brickearths, Pottery and Brickmaking in Gloucestershire,' *Proc. Cheltenham Nat. Sci. Soc.*, vol. i, pt. 4, 1910, p. 276.

CHAPTER III

INFERIOR OOLITE

The Inferior Oolite tract in the north-western part of the district is classic ground to the student of the Inferior Oolite Series. The main subdivisions of the Series and their fossil contents have been studied by many geologists from the days of Murchison and Hull onwards. It was not, however, until the late S. S. Buckman made known in 1895[1] the results of his researches that it was realized that hitherto the distribution of the fossils had not been studied with sufficient accuracy and that more minute subdivisions—that could be satisfactorily correlated with deposits of the same hemera elsewhere—could be made. By his careful palaeontological and stratigraphical work Buckman was enabled to indicate with considerable accuracy the distribution of the various subdivisions he had recognized, and in 1897[2] he presented a map showing the distribution of the subdivisions on which the Upper Trigonia Grit rests. After Buckman had communicated his 1895 paper Prof. T. T. Groom wrote to him, suggesting that the distribution of the subdivisions on which the Upper Trigonia Grit rests was the result of flexing and planation. At first Buckman was indisposed to accept the suggestion, but he did so in 1901[3] when he called the planation or denudation the ' Bajocian Denudation.' It is noticeable that the planed surface usually has oysters adhering to it and that the rock to which they are attached is, as a rule, well bored by annelids and *Lithophagi*.

As will be gathered from Buckman's map and a perusal of the following pages, the areas of deposition and the preservation of the subdivisions have been determined by movements along three main lines of earth weakness, namely along the Moreton anticlinal, Cleeve Hill synclinal, and Birdlip anticlinal axes. During early *bradfordensis, concavi, discitae* and *shirbuirniae* hemerae conditions were very unstable in the country immediately west of Bourton on the Water. In the area of its outcrop the Inferior Oolite rests everywhere non-sequentially on the Upper Lias.

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[1] 'The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, pp. 388-462.
[2] *Quart. Journ. Geol. Soc.*, vol. liii, 1897, pl. xlvi.
[3] *Idem*, vol. lvii, 1901, p. 128.

The Inferior Oolite Series : Mid (pars) *and North* (pars) *Cotteswolds*

Geological Survey		Approximate Zonal Terms used by Wright	Subdivisions	Hemerae (after S. S. Buckman)	Renevier's Chronographic Subdivisions
Inferior Oolite Series	Upper Stage	Parkinsoni Zone	Clypeus Grit	*schloenbachi-truellei* (late)	Vesulian
			[*Non-sequence*]		
			Upper Trigonia Grit	*garantianae*	
			[*Non-sequence*]		
		Humphriesianum Zone	Witchellia Grit	*witchelliae*	Bajocian
			Notgrove Freestone		
			Gryphite Grit	*shirbuirniae*	
			Buckmani Grit	post-*discitae*	
			Lower Trigonia Grit	*discitae*	
			[*Non-sequence*]		
			Snowshill Clay	*concavi*	
			Harford Sands		
			[*Non-sequence*]		
	Lower Stage	Murchisonae Zone	Upper Freestone	*bradfordensis*	Aalenian
			Oolite Marl		
			Lower Freestone	*murchisonae*	
			Pea Grit		
			Lower Limestone	*Ancolioceras*	
			Scissum Beds	*scissi*	
			[*Non-sequence*]		

Scissum Beds

The Scissum Beds consist, as a rule, of the usual yellowish sandy limestones locally decalcified to a loose brown sand. They extend apparently as far eastward as Sherborne and have an extent second only to the Clypeus Grit, but they are absent from the Rissington district to the east of the Vale of Bourton.

Pea Grit Series

At certain localities outside the present district the pisolitic beds of the Pea Grit rest on massive limestones in which pisolites are rare or from which they are absent. Where such is the case it is convenient to speak of Pea Grit and Lower Limestone, but in the present district such subdivision serves little purpose. What is noticeable, however, is that the ' Sandy Beds ' that constitute the top of the Pea Grit Series—for example at Cleeve Hill and in the railway-cutting at Syreford, near Andoversford—are well developed along the tract of country traversed by the Great Western Railway between Andoversford and Chedworth. In one of the cuttings along this railway is to be seen the passage laterally of typical Pea Grit into ' Yellow Stone.' ' Yellow Stone ' may be seen as far east as Bourton Hill Quarries (a quarter of a mile west of Coldpark Farm) near Bourton on the Water (Sheet 217) and in a quarry half a mile east-south-east from Farmington; but is absent from the Rissington district.

Lower Freestone

The Lower Freestone is well developed and has been quarried for building stone and lime-burning. The lowest beds seen in the railway-cutting near Withington consist of limestones—conspicuously bored—parted by marly layers. Similar layers part the Clypeus Grit from the ' Yellow Stone ' in the quarry half a mile east-south-east from Farmington.

In the Wagborough Bush Quarry, Upper Slaughter—a little to the north of the present district—the *Globirhynchia tatei* portion of the Upper Freestone rests non-sequentially on Lower Freestone.[1] At one time the writer was of the opinion that a similar relationship obtained locally in the hill country bordering the western margin of the Vale of Bourton, but he now considers it preferable to query certain rocks displayed in Hill Barn Quarry as Oolite Marl and in Duckleston Quarry, Sherborne, as Lower Freestone.

[1] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 59.

Oolite Marl

This subdivision is also well developed and very fossiliferous, but it is not now well exposed in any extensive section such as that in the railway-cutting at Notgrove and in the Westington Hill Quarry near Chipping Campden in the Cotteswolds to the north. The most fossiliferous exposures are those on the north-eastward facing slope of Charlton Kings Common, on Wistley Hill, at Turkdean, and in Foxhill (or Fox) Farm Quarry between Aston Blank and Clapton. The subdivision is absent from the quarry half a mile east-south-east from Farmington, where Clypeus Grit rests non-sequentially on the basement beds of the Lower Freestone; it is also absent from the Rissington district.

Upper Freestone

The Upper Freestone, as is the case also in the district to the north, is a variable deposit as regards lithic structure. It is displayed in its typical form, limestone, on Charlton Kings Common; as mainly marly rock containing *Globirhynchia tatei* (Davidson) in road-bank exposures near Withington (p. 28) and between the mill on the Coln and Stowell Park; and as hard limestone—very similar to Notgrove Freestone—in Newtown Quarry, Turkdean.

Harford Sands

The writer has detected traces of these Sands near New Barn, west by south of Aston Blank, so that a tongue of them extends thus far south from the vicinity of Harford Bridge in the district to the north (Sheet 217), but elsewhere in the present district they are absent.

Snowshill Clay

This deposit has a considerable extent in the district (Sheet 217) to the north of the present one, and in the heart of the North Cotteswolds is important in connexion with water supplies. But in the present district it is thin and occurs only in the north-western portion bounded approximately by a line joining, say, Coberley, Stowell and Aston Blank. Within this area, however, in a disused quarry just west of Cold Comfort Cottages, Buckman observed (see p. 25) Lower Trigonia Grit resting on Upper Freestone without the intervention of Snowshill Clay—an absence that would not have been expected. The Clay is clearly visible at Charlton Common (10 in. thick) and Wistley Hill (1 ft.); and has also been observed in the Chedworth Wood railway-cutting (6 in.), in the road-side bank about three-quarters of a mile east of Withington Church, and in Newtown Quarry, Turkdean (1½ ft.).

Lower Trigonia Grit

This ' Grit ' is the next subdivision in ascending order, the Tilestone being absent. It is very rich in lamellibranchs and contains locally what is known as ' The Second Coral Bed.' The best localities at which to collect fossils are Charlton Common and Wistley Hill. Eastward, in the direction of the Moreton anticlinal axis, the deposit attenuates and probably the pieces to be detected among the rubble at the top of the Newtown Quarry, Turkdean (p. 29), are remnants of the feather-edge of the subdivision.

Buckmani Grit

The Buckmani Grit—yellowish, sandy limestone usually considerably fossiliferous—is well developed, but attenuates to the eastward in the direction of the Moreton anticlinal axis, and dies out just before the disappearance of the underlying Lower Trigonia Grit. Along with its *Lobothyris buckmani* Sand and Marl it is well displayed on Charlton Kings Common, but from the quarry near Cowleywood the Sand is absent owing to the Bajocian Denudation, and the Upper Trigonia Grit there rests in some places on the Marl and in others on remarkably bored Buckmani Grit limestone.

Gryphite Grit

The extent of the Gryphite Grit, owing to the Bajocian Denudation (as will be seen on reference to Buckman's[1] map), is considerably less than that of the underlying Buckmani Grit. Where present, however, it is well developed : it consists of slightly sandy, massive-bedded limestones, and is characterized by a comparative abundance of specimens of *Gryphaea,* and, especially near the top, *Belemnites gingensis* Oppel. Other fossils, with the exception of *Entolium demissum* (Phillips), are rare—a fact that serves to distinguish it from the subjacent Buckmani Grit. The subdivision is well displayed in quarries along the top of Charlton Common (5 ft.) and in the railway-cutting through Chedworth Wood.

Notgrove Freestone

The Notgrove Freestone takes its name from Notgrove, in railway-cuttings near which its correct stratigraphical position was first determined by S. S. Buckman. Wherever it is seen succeeded by the Upper Trigonia Grit its top bed may be observed to be well bored by annelids. It is 5 ft. thick on Hartley Hill above Charlton Kings Common ; 30 ft. in the Chedworth Wood railway-cutting ; but, like the Lower Trigonia, Buckmani and Gryphite Grits,

[1] *Quart. Journ. Geol. Soc.*, vol. lvii, 1901, pl. vi.

attenuates to the eastward.[1] East of the Coln valley the only trace of the subdivision that the writer has found is a loose piece of the ' Bored Bed ' on the western side of the ' Turkdean valley ' east of Hazleton. In the district to the north (Sheet 217) the rock is extensively quarried for metalling the by-roads.

Witchellia Grit

Owing to the Bajocian Denudation the Witchellia Grit has escaped removal in only a very small area. It is a particularly interesting subdivision in that it is the only one of the Inferior Oolite of the Cotteswolds that contains ammonites somewhat abundantly. The ammonites enabled S. S. Buckman to correlate the rock with the Upper White Ironshot of Dundry Hill, near Bristol, and with the middle part of the ' Fossil Bed ' of Sandford Lane, near Sherborne, Dorset. *Tubithyris wrighti* (Davidson) is the characteristic brachiopod.

The Bourguetia and Phillipsiana beds of *sauzei* hemera (the hemera of ' The Ironshot ' of Dundry Hill), which are present in the Cleeve Hill Plateau, are absent from the present district as are also deposits of *blagdeni* and *niortensis* hemerae.

Before the Upper Trigonia Grit was laid down an elevatory movement occurred along the Moreton and Birdlip anticlinal axes and the line of maximum depression was along the axis of the Cleeve Hill syncline. Erosion, the Bajocian Denudation, ensued. Strata were removed according to their elevation and preserved according to their depression : consequently, the highest, the latest, subdivision that escaped removal is on the line of the Cleeve Hill synclinal axis, and, in the present district, is the Witchellia Grit. The plane of erosion is marked by the stratum on which the Upper Trigonia Grit (or, where this subdivision is overlapped, Clypeus Grit) rests, being waterworn, and the surface covered with oysters, and bored.

Upper Trigonia Grit

The Upper Trigonia Grit is a very fossiliferous rock and is well exposed at a number of localities—at Bull Banks (4 ft. 2 in. thick); in quarries near Cowley Wood (8 ft. 8 in.) and the Seven Springs (p. 26); and at Combend (10 ft. seen). North-eastward, however, it attenuates, being at Foxhill Farm Quarry 1 ft. 2 in. thick (p. 30), and in the hill country margining the western side of the Vale of Bourton it is overlapped by the Clypeus Grit, which rests at the Bourton Hill Quarries on ' Yellow Stone ' of *murchisonae* hemera, at Hill Barn Quarry, Clapton, on rock of *bradfordensis* hemera,

[1] That these subdivisions attenuate is clear from a study of the section in the Aston railway-cutting west of Bourton on the Water. See ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 80.

and at the quarry half a mile east-south-east from Farmington and Duckleston Quarry, Sherborne, on rock of *murchisonae* hemera.

The upper face of the Upper Trigonia Grit is often found to be covered with oysters and pitted—facts usually indicative of a non-sequence between the surface on which such phenomena are noticeable and the succeeding rock. From this district Dundry Freestone (late *garantianae* hemera) and the Upper Coral Bed (early *truellei* hemera) are absent.

Clypeus Grit

The well known Clypeus Grit completes the Inferior Oolite subdivisions and has the widest extent of them all. It is magnificently developed in the north-eastern portion of the district. At Bull Banks, near Duntisbourne Abbots, its thickness is about 20 ft.; in the ' seventh cutting ' from Andoversford in the direction of Chedworth—that near Cassey Compton—it is also about 20 ft.; at Gilbert's Grave, south-east of Aston Blank, 18¼ ft. without either the top or bottom being seen[1]; and in the Rissington district over 20 ft. At Iccomb Hill (Sheet 217), north of Little Rissington, according to Hull,[2] it measures from 30 to 40 ft. In the hill country bordering the western side of the Vale of Bourton this ' Grit ' has overlapped the Upper Trigonia Grit and in the Rissington district rests non-sequentially on Upper Lias clay.

As a rule the lower two-thirds of the Clypeus Grit consists of massive limestones and its upper third of rubbly limestones packed with fossils—notably *Terebratula globata* Auctt., *and Clypeus ploti* Klein. The topmost part of the ' Grit,' as is also the case in places in the North Cotteswolds, is locally—as in the Chedworth Wood cutting—somewhat ferruginous and of " the aspect of an ironshot oolite " (see p. 27).

[1] From the basal portion of the Clypeus Grit exposed in an old quarry near Bourton Hill Farm a specimen of the rare echinoid *Pygaster macrostoma* Wright has been obtained. See L. Richardson and E. T. Paris ' On the Stratigraphical and Geographical Distribution of the Inferior Oolite Echinoids of the West of England,' *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 2, 1908 p. 176.

[2] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 47.

Table to demonstrate variations in thickness and distribution of the Inferior Oolite Series in the area represented on Sheet 235

		Subdivision	Bull Banks near Duntisbourne Abbots	Leckhampton Hill near Cheltenham	Chedworth Wood	Turkdean	Hill Barn, Clapton	Rissington District
Inferior Oolite Series	Vesulian	Clypeus Grit	20* 0	present	20 0	present	+8 0	30 to 40 (E. Hull)
		[*Non-sequence*]						
		Upper Trigonia Grit	4 2	+5 0	5 0	thin	—	—
	Bajocian	[*Non-sequence*]						
		Witchellia Grit	—	—	See p. 28	—	—	—
		Notgrove Freestone	—	4 0	30 0	—	—	—
		Gryphite Grit	—	5 0	4 0	—	—	—
		Buckmani Grit	—	11 8	10 1	—	—	—
		Lower Trigonia Grit	—	5 9	5 4	trace	—	—
		[*Non-sequence*]						
	Aalenian	Snowshill Clay	—	1 6	0 6	1 6	—	—
		Harford Sands	—	—	—	See p. 16	—	—
		[*Non-sequence*]						
		Upper Freestone	?75 10	32 0	?15 0	10 0 +	—	—
		Oolite Marl		10 0	? 8 0	6 0	?2 8	—
		Lower Freestone		77 9	38 2	46 0	5 0 +	—
		Pea Grit		20 10	26 6		probably represented	—
		Lower Limestone		9 5				—
		Scissum Beds		9 9	18 0	14 0		—
		Opaliniforme Bed	No information	—	—	—	—	—
		Venustula Bed		—	—	—	—	—
		Digna Bed		—	—	—	—	—
		Cotteswoldia Bed		—	—	—	—	—

* Thicknesses are in feet and inches. A plus sign before a thickness indicates that the top of the subdivision had been removed; after, that the lower part was not exposed.

Details

At Bull Banks, about 1 mile west by north from Duntisbourne Abbots, the following sequence may be made out in the sides of the trackway and in old quarries :—

Sequence at Bull Banks

		Ft.	In.
	Stonesfield Slate Series	—	—
Fullers' Earth	Clay ... ... about	12	0
	Ostrea acuminata-Limestone with a crush of the oysters immediately above and below	0	3
	Clay	12	0
Inferior Oolite	Clypeus Grit. Typical ... estimated at	20	0
	[*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]		
	Upper Trigonia Grit. Typical	4	2
	[*Non-sequence :* deposits of *niortensis-concavi* hemerae (inclusive) absent].		
	Upper Freestone. Top bed hard and well bored. Oolite Marl, here mainly limestone ; *Globirhynchia subobsoleta* (Dav.) and *Plectothyris fimbria* (J. Sowerby) ...	?75	10
	Lower Freestone		
	[Pea Grit Lower Limestone } Evidence in neighbourhood Scissum Beds]		

The base of this sequence is at about 490 ft. above Ordnance Datum.

The Birdlip anticlinal axis, as indicated by the late S. S. Buckman, runs *via* Brimpsfield, Winstone, Duntisbourne Abbots, and Ivy Lodge in Cirencester Park. Along this line the Inferior Oolite rocks should be of less thickness than elsewhere in the district.

Proceeding northwards one crosses the axis at about 2 miles north of Bull Banks. At 3½ miles north of Bull Banks, or 1½ miles north-west from Elkstone Church, at the western extremity of Cowley Wood, is the ' Quarry near Cowley Wood.' The occurrence of Buckmani Grit beneath the Upper Trigonia Grit shows that progress is being made toward the Cleeve Hill synclinal axis.

Quarry near Cowley Wood[1]

		Ft.	In.
Clypeus Grit	1. Typical ... ... seen for	3	0
	2. Limestone ; very few fossils	1	1
	[*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]		
Upper Trigonia Grit	3. Typical	8	8
	[*Non-sequence :* deposits of *niortensis-witchelliae* hemerae (inclusive) absent]		
Buckmani Grit	4. The Buckmani Marl. Shale, greyish, arenaceous ; *Acanthothyris globosa* S. Buckman, *Lobothyris buckmani* (Davidson), *L. crickleyensis* (S. Buckman) ...	0	4
	5. Limestone, hard, grey, sandy, much bored by *Lithophagi*, less so by annelids; *L. buckmani* (Davidson), *Trigonia formosa* Lycett, *Gervillia praelonga* Whidborne, *Galeolaria socialis* (Goldfuss), etc. ... ... seen for	1	5

[1] Abridged record ; for detailed account see L. Richardson, ' On a Section at Cowley, near Cheltenham and its Bearing upon the Interpretation of the Bajocian Denudation,' *Quart. Journ. Geol. Soc.*, vol. lix, 1903, p. 382 ; 'A Handbook to the Geology of Cheltenham. . . . ,' 904, pp. 112, 113.

Bed 4 is locally absent, but when present rests on an exceedingly irregular surface of bed 5. Where bed 4 is absent bed 5 is very much bored—especially by *Lithophagi*. The surface of the Upper Trigonia Grit is covered with oysters and the top bed is bored in places.

About 3 miles farther north is Hartley Hill on the northern slope of which is Charlton Kings Common. The sections on the Common, and especially on the neighbouring Leckhampton Hill, have been described by many geologists[1]: the following generalized section is based mainly on information recorded by S. S. Buckman.[2]

Charlton Kings Common

		Ft.	In.
Upper Trigonia Grit	Ragstone, shelly	—	—
	[*Non-sequence*: deposits of *niortensis-witchelliae* (late) hemerae (inclusive) absent]		
Notgrove Freestone	Limestone, hard oolitic; top bed much bored	4	0
Gryphite Grit	Limestones, hard, sandy; *Gryphaeae* abundant	5	0
Buckmani Grit	Limestones, yellow sandy; *Charltonithyris uptoni* (S. Buckman), occasional *Gryphaeae*	7	8
	The Sand Bed. Sand, bright yellow and sandy stone	0	6
	The Buckmani Marl. Marl, yellowish and purplish; *Acanthothyris globosa* S. Buckman[3], *Lobothyris buckmani* (Davidson)	1	0
	Limestone, hard, yellow, sandy; *Serpula spp.* abundant in the lower bed ...	2	6
Lower Trigonia Grit	Stone, crumbly, slightly ironshot; occasional *Gryphaeae*, numerous lamellibranchs	3	5
	Hard band similar to the above; *Pseudomelania*	0	8
	Meriani Bed. Marl, brown, soft; *Aulacothyris meriani* (Oppel) fairly common, *Lobothyris* cf. *cortonensis* (S. Buckman)	0	4
	Hard band	0	7
	Marl, crumbly, calcareous, earthy ...	0	6
	Stone, earthy	0	3
Snowshill Clay[4]	Clay, yellow, brown and blue, somewhat sandy	0	10
Upper Freestone	Grey, disintegrated oolitic debris... ...	0	3
	Limestone, oolitic, slightly pinkish ...	—	—
	Freestone, white oolitic	—	—

The Oolite Marl and Upper Freestone are easily accessible. The best exposure is in the hillside above the 'gravel pit.' At about 2 in. above the Lower Freestone the writer once found a ventral valve of the rare brachiopod *Pseudoglossothyris galeiformis* (M'Coy). Fossils that are common in the Oolite Marl here are :—*Natica cincta* Phillips, *Nerinea spp.*, *Alectryonia* cf. *flabelloides*

[1] See J. W. Gray, 'Leckhampton Hill, Gloucestershire : The Wellington Quarry and other sections,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1, 1924, p. 40.

[2] 'The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 412.

[3] 'The Brachiopoda of the Namyau Beds of the Northern Shan States, Burma,' *Palaeontologia Indica*, n.s., vol. iii, Mem. 2, 1917, p. 230.

[4] Given in Buckman's 1895 record as 'Harford Sands equivalent' but referred by him in 1897 (*Quart. Journ. Geol. Soc.*, vol. liii, p. 611) to the Snowshill Clay.

(Lamarck), *Granulirhynchia* aff. *granulata* (Upton), *Flabellirhynchia lycetti* (Davidson), *Curtirhynchia* cf. *oolitica* (Davidson), *Globirhynchia subobsoleta* (Davidson), *Pseudoglossothyris curvifrons* (Oppel), *P. nana* S. Buckman, *Epithyris submaxillata* (Morris), *Plectothyris fimbria* (J. Sowerby), *Lophrothyris notgroviensis* (S. Buckman), *? L. whitakeri* Walker, *Zeilleria leckenbyi* (Walker), *Z. witchelli* (S. Buckman), *Adelastraea consobrina* (M. Edwards and Haime). Oolite Marl is also exposed on the north-east side of the hill.

Snowshill Clay is seen above the Upper Freestone in an old quarry the site of which is three furlongs north by east of Hartley Farm on Charlton Kings Common.

The Lower Trigonia Grit is well displayed in an old excavation a few yards to the east of where the Snowshill Clay is exposed. The Meriani Bed occurs at 2 ft. 2 in. above the Freestone and the characteristic brachiopod is abundant. In this section the rock above the Meriani Bed is crowded with lamellibranchs.

The Buckmani Grit may be studied in the quarry at the top of the road —on the summit of the Common.

Gryphite Grit, very rich in specimens of *Gryphaea*, is exposed in the quarries along the edge of the summit of the Common.

Section at Wistley Hill[1]

		Ft.	In.
Buckmani Grit	Limestone ; *Lobothyris buckmani* (Davidson)	1	6
Lower Trigonia Grit	Limestone, rubbly ironshot, irregularly mixed with marl ; *Hyperlioceras sp.*, *Gryphaeae*, *Opis cordiformis* Lycett, corals	3	6
	Meriani Bed. Marl, brown and marly stone ; *Aulacothyris meriani* (Oppel)	0	4
	Yellowish marly stone and marl	0	9
	Marl, brown earthy	0	2
	Stone, slightly ironshot, shelly	1	1
	Stone, marly, crumbly	0	6
Snowshill Clay[2]	Yellowish-brown and bluish somewhat argillaceous sand	1	0
	Brownish, bluish and greyish arenaceous clay	1	7
Upper Freestone	Whitish oolitic debris	0	3
	Freestone, white oolitic	—	—

The above beds are faulted down against Upper Freestone (basement bed), Oolite Marl and Lower Freestone (top portion).[3] The Oolite Marl is very fossiliferous, *Pseudoglossothyris curvifrons* (Oppel) being the most abundant form. In the harder parts of the Marl specimens of *Nerinea* are not uncommon, together with clusters of *Galeolaria socialis* (Goldfuss).

" About ½ mile south-east of Wistley Hill is Chatcombe Pitch. There is a small section on the top of the Pitch, south side, by the edge of the Wood ; and on the north side are openings, of rather incomplete nature, in the Oolite Marl and Lower *Trigonia*-grit."[4] Probably this exposure of the Oolite Marl was the one seen by Prof. John Phillips.[5]

The Lower Trigonia Grit at Wistley Hill is highly fossiliferous and there are indications of a coral bed—that known as the ' Second Coral Bed.'

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[1] Buckman says ('The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 413) : "... this is the section called by Wright and others ' Ravensgate,' a name that I have used in various papers. However, in the Ordnance Survey maps it is marked as 'Wistley Hill' ; while Ravensgate Hill is the next promontory eastwards."

[2] Identified as a ' Representative of the Harford Sands ' by Buckman in his 1895 paper, but correlated with the Snowshill Clay in his 1897 paper on ' Deposits of Bajocian Age in the Northern Cotteswolds : The Cleeve Hill Plateau, ' *Quart. Journ. Geol. Soc.*, vol. liii, p. 611.

[3] Richardson, L., ' A Handbook to the Geology of Cheltenham . . . ,' 1904, p. 93.

[4] Buckman, S. S., *op. cit.*, *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 414.

[5] ' Geology of Oxford and the Valley of the Thames,' 1871, p. 145.

On the spur of Wistley Hill above Vineyards Farm is slipped Inferior Oolite rock—the bulk of it Scissum Beds and Pea Grit.[1] From the Scissum Beds may be collected many excellently preserved brachiopods such as *Aulacothyris blakei* (Walker), *Quadratirhynchia cheltiensis* (Richardson and Upton)[2], *Q. subdecorata* (Davidson) and *Euidothyris euides* (S. Buckman).

On the eastern flank of Ravensgate Hill, on the parish boundary in the wood some half a mile west of the 11th milestone from Gloucester on the Gloucester-Oxford road, is a disused quarry in which Lower Trigonia Grit and Snowshill Clay are well exposed. The section has been described by Buckman.[3]

Quarry on Ravensgate Hill

		Ft.	In.
Buckmani Grit	Limestone, grey sandy; *Lobothyris buckmani* (Davidson), *Gryphaea sublobata* (Deshayes), etc. ... ... seen for	2	0
Lower Trigonia Grit	Rubbly stone and marl	1	6
	Slightly ironshot stone	4	6
	Marly stone	0	4
	Meriani Bed. Marl, yellowish; *Aulacothyris meriani* (Oppel)	0	3
	Ragstone, grey; *Gresslya abducta* (Phillips)	1	8
	'Second Coral Bed.' Marly stone; *Heterastraea sp.*, *Isastraea tenuistriata* (M'Coy), *Phyllogyra etheridgei* (Duncan)	1	2
	[*Non-sequence :* Tilestone absent]		
Snowshill Clay	Blue clay	0	5
	Yellow clay	0	2
	[*Non-sequence :* Harford Sands and Naunton Clay absent]		
Upper Freestone	Freestone, white oolitic; pink bed at the top ... ... seen for	13	0

Half a mile to the east, on the north side of the Gloucester-Oxford road near the 11th milestone from the former place, Witchellia Grit (2 ft. 11 in.) is visible between the Upper Trigonia Grit and Notgrove Freestone. The section has been described by Buckman[4] and need not be repeated here because the Witchellia Grit is much better displayed, thicker and more fossiliferous, in the classic Cold Comfort Quarry some 500 yards farther east. The following is Buckman's record[5] of the strata displayed in this quarry and in the vicinity.

Cold Comfort Quarry

		Ft.	In.
"*Witchellia*-grit	1. Grey, shelly, sandy stone, not ironshot; *Acanthothyris* cf. *paucispina*, small forms rather common but often only single valves; larger specimens scarce. *Pseudomelania* (?) cast, *Bourguetia* (?) cast. Small elongate *Terebratula*. Thickness about	1	0
	2. Similar stone; but no fossils were noticed	1	0
	3. Greyish, rather ironshot, shelly stone. Various species of *Witchellia* and *Terebratula Wrighti*		5

[1] Richardson, L., 'Handbook to the Geology of Cheltenham. . . ,' 1904, p. 70.
[2] 'Some Inferior Oolite Brachiopoda,' *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 1, 1912, p. 47.
[3] Buckman, S. S., *op. cit.*, *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 415.
[4] *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 41. See also L. Richardson, 'Handbook to the Geology of Cheltenham. . . ,' 1904, p. 121.
[5] *Idem*, p. 417.

		Ft.	In.
"*Witchellia*-*grit*	4. Greyish, fairly ironshot, shelly stone. The iron grains are rather angular in shape; they fall out and leave the stone pitted. Flattish *Terebratula*. Small smooth *Pecten* rather common		6
	5. Somewhat cream coloured, shelly stone, broken up and mixed with rubbly marl. Weathered pieces show polyzoa	1	1
Notgrove Freestone	6. Whitish limestone, with a more or less pink tinge and iron-stains, considerably bored, in places more than 1 foot vertically; *Ostreae* and *Gryphaeae* occasionally, although the rock is generally unfossiliferous	2	3
	7. Whitish limestone, 'Freestone,' with small whitish oolite-grains; visible ...	7	0
Gryphite- and *Buckmani*-grits hidden	8. From the top of the Notgrove Freestone to the base of the Lower *Trigonia*-grit, shown resting on the top of the Upper Freestone in a disused quarry just west of Cold Comfort Cottages, on the right-hand side of the road from Gloucester to Oxford, is 30 feet. Therefore 30—9 gives	21	0
Upper Freestone	9. From the top of the Upper Freestone to an exposure of Oolite Marl on the left-hand side of the road, just east of Cold Comfort Cottages is 18 feet. Immediately W. of the cottages, on the same side and in the same field as the top quarry, is an Upper Freestone quarry about 15 feet deep	18	0
Oolite Marl	10. Marl with *Terebratula fimbria* and characteristic fossils."		

More than eighty-five years ago James Buckman obtained from the Witchellia Grit here an ammonite that he identified as *Ammonites laeviusculus*.[1] This and 'finds' of allied forms enabled his son, the late S. S. Buckman, to correlate the deposit in which they occurred with the Upper White Ironshot of Dundry Hill, near Bristol,[2] and with the middle part of the Sandford Lane (near Sherborne, Dorset) 'Fossil Bed.'[3]

Tubithyris wrighti (Davidson) is a somewhat abundant fossil occurring mostly in the earthy marl that separates the rubbly rock: rarer brachiopods of the Witchellia Grit are *Epithyris* cf. *submaxillata* (Morris) and *Zeilleria tenuis* Richardson and Upton.[4]

The bottom 6 in. of the Witchellia Grit was Dr. T. Wright's 'Perna Bed'[5]: therefrom he obtained *Tubithyris wrighti* (Davidson),[6] but the rock that yielded *Pernae* so abundantly in the past appears to have been quite worked out.

The present extent of the Witchellia Grit in the district under consideration can be fairly accurately determined. About three-fifths of a mile south

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[1] Murchison's 'Outline of the Geology of ... Cheltenham,' 2nd. ed. by H. E. Strickland and James Buckman, 1844, p. 27.

[2] *Quart. Journ. Geol. Soc.*, vol. lii, 1896, table facing p. 704.

[3] *Idem*, vol. li, 1895, p. 421.

[4] 'Some Inferior Oolite Brachiopoda,' *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. i, 1912, p. 56.

[5] 'Subdivisions of the Inferior Oolite,' *Quart. Journ. Geol. Soc.*, vol. xvi, 1860, p. 42.

[6] Davidson, T., 'Jurassic Brachiopoda,' *Palaeont. Soc.*, 1854, Appendix to vol. i, p. 20 and vol. iv, p. 140.

by east of the Cold Comfort Quarry, on the left-hand side of the road leading to Hilcot and 220 yds. east of Pegglesworth Hill, is Buckman's ' Rough Hill Bank Quarry,'[1] in which the Upper Trigonia Grit (4 ft. seen) is displayed resting on Notgrove Freestone (the top bed of which is much bored) without the intervention of any Witchellia Grit. In a cutting on the Cirencester road, 4¾ miles south by east from the Rough Hill Bank Quarry and half a mile north-north-west from Rendcomb Park, the Notgrove Freestone has gone, whilst the Upper Trigonia Grit rests on rock that is presumably Gryphite Grit.

Half a mile south-east by east from the Seven Springs the Clypeus Grit is well displayed in an old quarry and is very fossiliferous. The section is as follows :—

Quarry near the Seven Springs

		Ft.	In.
Clypeus Grit	Typical, usual fossils ... seen for	2	0
	Limestone, grey, fine-grained ; few fossils ...	2	2
	[*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]		
Upper Trigonia Grit	Ragstone, compact, shelly, with a layer of oysters on top; usual fossils ... seen for	5	4

A little to the west is a quarry in which the Lower Trigonia Grit is displayed, with the Meriani Bed containing abundant *Aulacothyris meriani* (Oppel).

Another quarry where many fossils may be obtained from the Clypeus (4½ ft. seen) and Upper Trigonia (10 ft. seen) grits is Combend Quarry, close to the road on the 700-ft. contour-line, one mile west-south-west of Colesborne Church.

The Buckmani Grit, with the top bed bored, is to be seen in a quarry to the north of the Cirencester road near Hill Barn, Upper Coberley. Oolite Marl is well exposed in quarries on the hillside south of Upper Coberley and at about a mile north-west of Colesborne where specimens of *Nerinea* are very abundant. Lower Freestone has been worked three-quarters of a mile west by south from Coberley village, while typical Pea Grit has been proved in an excavation on the north side of Cowley Wood near the pool ; it is exposed—slipped somewhat—at Wine's Well, Colesborne, and is quarried by the side of the Cirencester road opposite the turning to Marsden.

Sections on and near the Great Western Railway[2] *between Andoversford and the Chedworth Tunnel.*—Since the Cleeve Hill synclinal axis traverses this tract of country in close proximity to the railway, it follows that more subdivisions of the Inferior Oolite are preserved along this line of country than elsewhere in the district under consideration (see table p. 20).

It is unnecessary to deal in detail with all the sections in the railway-cuttings because they have been adequately described by the late S. S. Buckman[3] and H. B. Woodward.[4]

The First Cutting (A of H. B. Woodward) from Andoversford is at the dismantled Dowdeswell Station and is mainly in tumbled, much broken, freestone.

The Second Cutting (B), south of the Frogmill Inn, displays the basal portion of the Lower Freestone and the Sandy Beds (23 ft.) and massive pisolitic beds (23½ ft. seen) of the Pea Grit Series. *Costirhynchia shiptonensis* (S. Buckman) is abundant in the Sandy Beds here.

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[1] ' The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, p. 423.

[2] *Olim* Midland and South Western Junction Railway.

[3] ' The sections exposed between Andoversford and Chedworth : a comparison with similar strata upon the Banbury Line,' *Proc. Cotteswold Nat. F. C.*, vol. x, 1892, pp. 94-100.

[4] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, pp. 125-9.

Massive pisolitic beds are displayed in a cutting on the Oxford road half a mile north, and Lower Freestone in ' The Pitch Quarry ' in a field alongside the same road a quarter of a mile north-east of the above railway-cutting.

The Third Cutting (C), near Northfield Farm and west of Cleevely Wood, displays the sequence from the Upper Lias to the pisolite of the Pea Grit. Proceeding down the cutting southwards one sees in turn typical Pea Grit, then just before the bridge the anticline with Upper Lias clay in the core (p. 11) succeeded by Scissum Beds, etc., and south of the bridge typical Pea Grit again.

The Fourth Cutting (D), west of Ravensdale Farm, is now partly overgrown, but it still displays Pea Grit particularly pisolitic near the top.

The Fifth Cutting (E) is at Withington Station and is through Upper Lias.

The Sixth Cutting (F) displays the basal portion of the Lower Freestone, and Sandy Beds and massive freestones belonging to the Pea Grit Series. Here may be seen the passage, laterally, of pisolitic limestones into ' Yellow Stone.'

Woodward's cutting G displays Upper Freestone: his cutting H shows Upper Freestone (top), Snowshill Clay (1 to 1½ ft.) and Ragstone.

The Seventh Cutting (J) shows beds arranged in a gentle synclinal: according to Buckman[1] the sequence is as follows :—

	Ft.	In.
Fullers' Earth	—	—
Clypeus Grit ... ... about	20	0
Upper Trigonia Grit	5	0
Notgrove Freestone ... ... seen for	3	6

Woodward says[2] : " The top of the Clypeus Grit, is a hard brown iron-shot oolite, with *Pholadomya, Homomya, Terebratula globata,* and *Clypeus Ploti ;* and above, there is about 6 feet of stiff red and blue clay with bands of ferruginous limestone at the base, yielding also *Pholadomya* and *Homomya.* These bands, which here seem hardly separable from the Fullers' Earth, are doubtless equivalent to the oolitic and sandy ragstones [Chipping Norton Limestone] that overlie the Clypeus Grit between Notgrove and Bourton-on-the-Water."

The Eighth Cutting (K), near the tumulus in Chedworth Wood, is of noble proportions. The section (which formerly displayed a faulted-in mass of Fullers' Earth, now faced with stone-work)[3] was first described by Buckman in 1890. In 1894 Woodward[4] pointed out certain errors in Buckman's identifications, and in 1895 the latter[5] published an amended record of the beds from the Notgrove Freestone downwards. In this record Buckman designated the deposit now known to be Snowshill Clay, ' Harford Sands equivalent,' but he corrected the matter in 1897.[6] The following section is based on Buckman :—

Chedworth Wood Cutting

		Ft.	In.
Fullers' Earth	Clay, blue	—	—
?Chipping Norton Limestone	Limestone, hard, reddish, with darker grains	0	7
	Marl, clayey	0	4
	Limestone, rubbly, brown, with coarse dark grains	3	0
?Roundhill Clay	Brown decomposed paste	0	3
Clypeus Grit	Typical ; " top portion somewhat ferruginous, and presented the aspect of ironshot oolite " [H. B. Woodward] ... about	20	0
	[*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]		

[1] *Loc. cit.*, p. 99.
[2] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 129.
[3] *Proc. Cotteswold Nat. F. C.*, vol. x, 1892, pp. 97-99.
[4] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, pp. 127-9.
[5] ' The Bajocian of the Mid-Cotteswolds,' *Quart. Journ. Geol. Soc.*, vol. li, 1895, pp. 425, 427.
[6] *Quart. Journ. Geol. Soc.*, vol. liii, 1897, p. 611 (footnote 3).

		Ft,	In.
Upper Trigonia Grit	Typical ... ... about [*Non-sequence ;* deposits of *niortensis* to *witchelliae* (late) hemerae (inclusive) absent]	5	0
Notgrove Freestone	Limestone, hard, white, oolitic, top bed well bored ; *?Sonninia* at 4½ ft. above base	30	0
Gryphite Grit	Limestone, greyish, somewhat marly ; *Gryphaeae* abundant	4	0
Buckmani Grit	Limestones, sandy	10	1
Lower Trigonia Grit	Ironshot marl and stone ; lamellibranchs ...	0	11
	Stone, pinkish ; lamellibranchs	1	2
	Stone, yellowish	1	3
	Meriani Bed. Marl ; *Aulacothyris meriani* (Oppel)	0	2
	Stone, yellowish, slightly ironshot	1	5
	Marl and stone	0	5
	[*Non-sequence :* Tilestone absent]		
Snowshill Clay	Clay, bluish and yellowish with numerous fragments of shells ; *Ostreae* ... ... [*Non-sequence :* Harford Sands and Naunton Clay absent]	0	6
Upper Freestone	Limestone, yellowish and bluish, oolitic ...	—	—

From the next cutting (L) Snowshill Clay is absent.

It will have been noticed that Witchellia Grit and Oolite Marl are absent from the sections described. The late S. S. Buckman once informed the writer that he had found rubble of the ' Grit ' on a field a quarter of a mile north-west of Shipton Church, so this subdivision once crossed the line of the present railway in the neighbourhood of Dowdeswell Station (dismantled). The Oolite Marl is present in the neighbourhood of Chedworth Wood but lies below the level of cuttings. Along the north side of the road from Withington to Compton Abdale, at about three-quarters of a mile east of Withington Church, the following subdivisions may be made out in descending sequence : Upper Trigonia Grit, Notgrove Freestone (top bed bored), Gryphite Grit, Buckmani Grit (very fossiliferous), Lower Trigonia Grit, Snowshill Clay, Upper Freestone (yellowish-white oolitic freestone with *Globirhynchia tatei* (Davidson)), passing down into Oolite Marl (with *Globirhynchia subobsoleta* (Davidson), *Plectothyris fimbria* (J. Sowerby) and *Lucina sp.*).[1] " These marls [Oolite Marl] with *Terebratula fimbria* were exposed by the road-side to the east of the Roman Villa, and they occur above [Lower] Freestone that is worked in a quarry on Yanworth Common."[2] Scissum Beds have been observed near Cassey Compton.[3]

East of the Coln valley the Notgrove Freestone continues to be the subdivision on which the Upper Trigonia Grit rests as far as the approximate limit-line shown on the map accompanying S. S. Buckman's 1901 paper.

On the east side of the road near Newtown, on the valley side facing Turkdean, a quarry displays the following section :—

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[1] Richardson, L., ' Handbook to the Geology of Cheltenham . . . ,' 1904, p. 94.
[2] Woodward, H. B., ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 127.
[3] Richardson, L., *op. cit.*, p. 72.

Newtown Quarry, Turkdean[1]

		Ft.	In.
Clypeus Grit	A little rubble, pisolitic ; *Terebratula globata* Auctt.	—	—
	[*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]		
Upper Trigonia Grit	Rubble, non-pisolitic ; usual fossils ...	—	—
	[*Non-sequence :* no evidence for Notgrove Freestone, etc.]		
Lower Trigonia Grit	Evidence—A piece of marly limestone containing a specimen of *Tubithyris degenerata* (Upton)	—	—
Snowshill Clay	Clay, white and grey	1	0
	Clay, black	0	6
	[*Non-sequence :* Tilestone, Harford Sands and Naunton Clay absent]		
Upper Freestone	Limestone, oolitic, regularly bedded, but 'open jointed' and shattered seen for	10	0

The lithic characters of the Upper Freestone here remind one of those of the Notgrove Freestone (*cf.* Upper Freestone of the Hill Barn Quarry, Clapton, p. 31, and of the Duckleston Quarry, Sherborne, p. 32).

Lower beds are seen to the north in old quarries alongside the road that climbs the hill to Turkdean, as under :—

Old Quarries near Turkdean

		Ft.	In.
Oolite Marl	Marl, white and yellow	2	4
	Limestone, hard, white, marly ; *Plectothyris fimbria* (J. Sowerby)	2	0
	Marl, white, and rubbly limestone ; *Natica leckhamptonensis* Morris and Lycett, *Lobothyris whitakeri* (Walker)	1	8
Lower Freestone	Freestone, regularly bedded but open-jointed : seen (in old quarry below) for 30 ft., but according to Hull[2]	46	0
?Scissum Beds	'Yellow sandstone,' thickness according to Hull	14	0

Oolite Marl and Lower Freestone are seen in an old quarry in the valley side nearly half a mile west of the Manor House, Turkdean.

East of Turkdean the Upper Trigonia Grit becomes attenuated and dies out in the hills overlooking the Vale of Bourton.

On the west side of the Fosse Way north of Gilbert's Grave is a quarry in Clypeus Grit which is crowded at certain horizons with fossils ;[3] it shows :—

Gilbert's Grave Quarry—No. 1

		Ft.	In.
Clypeus Grit	Rubble ... ... seen for	1	0
	Marl and rubble packed with specimens of *Terebratula globata* Auctt., *Clypeus ploti* Klein, *Pholadomya sp.*	1	3
	Limestone ; comparatively few fossils ...	5	6
	Marl, yellow ; *Terebratula globata* Auctt., *C. ploti* Klein and *Pleuromya sp.* common	0	6
	Limestone, massive-bedded... seen for	10	0

Close by, to the south, east of the Fosse Way, a quarry 'in work' displays lower beds.

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[1] Richardson, L., 'Excursion to Turkdean and Sherborne,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2, 1925, p. 83.

[2] 'The Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 40.

[3] Richardson, L., 'Excursion to Turkdean and Sherborne,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2, 1925, p. 83 ; *Proc. Geol. Assoc.*, vol. xviii, pt. 8, 1904, p. 404.

Gilbert's Grave Quarry—No. 2

		Ft.	In.
Clypeus Grit	Rubble—some pieces with large ooliths ... [*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]	—	—
Upper Trigonia Grit	Ragstone ; *Acanthothyris spinosa* (Schloth.) [*Non-sequence :* deposits of hemerae *niortensis* to *concavi* (inclusive) absent]	—	—
? Oolite Marl	Limestone, hard, grey, obscurely oolitic, surface level, covered with oysters, bored ; indeterminable shell-fragments	2	6
Oolite Marl	Marl, oolitic, buff, brown and yellowish with thin lenticles of grey clay, stony in places with a band of stone near the top ; *Plectothyris fimbria* (J. Sowerby) (rare), isocrinoid ossicles	1	9
	Limestone, oolitic, pinkish	1	3
	Limestone, marly, oolitic, pinkish, with a layer of brown marly clay in the upper part. In the lower part pebbles of oolite occur and *Plectothyris fimbria* (J. Sowerby) is common ; *Epithyris submaxillata* (Morris)	2	0
	Oolite, creamy yellow with a 'rubbly fracture' ; *Plectothyris fimbria* (J. Sowerby)	2	8
Lower Freestone	Limestone, sparsely oolitic, hard, regularly bedded ... ... seen for	3	6

In 1925 the Cotteswold Naturalists' Field Club visited this locality and Duckleston Quarry, Sherborne.[1] In the report of the excursion records of the sections in these quarries and in Hill Barn Quarry, Clapton, are given and certain beds are referred to as Upper Freestone. The identification may be found to be correct eventually, but further consideration appears to make it desirable tentatively to adopt the correlations suggested in this memoir.

Oolite Marl is visible in a quarry—now almost overgrown—near Sweetslade Farm,[2] 520 yards south by west of No. 2 Gilbert's Grave.

About the same distance but south-east of the latter is a quarry near Foxhill Farm (Fox Farm of the one-inch map), with the following section :—

Foxhill Farm Quarry

		Ft.	In.
Clypeus Grit	Typical ... ... seen for [*Non-sequence :* Upper Coral Bed and Dundry Freestone absent]	8	0
Upper Trigonia Grit	Ragstone ; usual fossils ... ... [*Non-sequence :* deposits of *niortensis* to *concavi* hemerae (inclusive) absent]	1	2
?Oolite Marl	Limestone, oolitic, cream-coloured, rubbly in the lower portion. Top portion slightly bored ; *Plectothyris fimbria* (J. Sowerby) up to	1	6

[1] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2, 1925, pp. 84-6.

[2] Hull gives a section of Ragstone overlying Oolite Marl "in a quarry near a barn east of the Roman Fosseway" ('The Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 38). Possibly this was the quarry. It was visited by the Geologists' Association of London in 1904 ; *Proc. Geol. Assoc.*, vol. xviii, pt. 8, 1904, p. 403.

		Ft.	In.
Oolite Marl	Marl and rubbly limestone ; *Globirhynchia subobsoleta* (Davidson) (common), *Plectothyris fimbria* (J. Sowerby), *Epithyris submaxillata* (Morris), *Trigonia sp.* ...	1	9
	Limestone, yellowish, with yellow ooliths ; *Plectothyris fimbria* (J. Sowerby) in the upper part...	2	0
Lower Freestone	Limestone, very oolitic, obliquely bedded seen for	4	0

Seven furlongs east-south-east of Gilbert's Grave Quarry No. 2, near Hill Barn, Clapton, is a quarry ' in work ,' with an extensive clear-cut vertical face[1] that showed the following sequence :—

Hill Barn Quarry, Clapton

		Ft.	In.
Clypeus Grit	Typical ; packed with fossils—*Clypeus ploti* Klein at the very bottom...seen for	8	0
	[*Non-sequence :* deposits of *truellei* (early) to *concavi* hemerae (inclusive) absent]		
?Oolite Marl	Limestone, hard, with white ooliths. Top level, covered with oysters, bored. Very barren, but a single specimen of *Plectothyris fimbria* (J. Sowerby) was discovered	1	6
Oolite Marl	Limestone weathering slightly rubbly, more marly than the bed above, oolitic ; *Plectothyris fimbria* (J. Sowerby), *Globirhynchia sp., Nerinea sp., Lucina sp.* ...	1	2
Lower Freestone	Limestone, oolitic, in regular beds which are obliquely laminated ... seen for	5	0

Owing to this quarry being situated nearer to the southward prolongation of the Moreton anticlinal axis, along which frequent movements took place in Inferior Oolite times, comparison of this section with those in the preceding three quarries reveals that the rock of *bradfordensis* hemera, namely, the Oolite Marl, is thinner, and that the Upper Trigonia Grit is absent. The rock queried as Oolite Marl is very much like Notgrove Freestone (*cf.* with similar bed in Duckleston Quarry, p. 32).

At the Bourton Hill Quarries, a quarter of a mile west of Coldpark Farm, debris of Clypeus Grit is to be seen above the ' Yellow Stone ' (hemera *murchisonae*).

Typical Clypeus Grit has been quarried for lime-burning on the west side of the road about half-way between Farmington and Hill Barn—at a point half a mile west of Farmington Church.

At the same distance east-south-east of the church, Farmington, the following section is displayed in a quarry by the road side :—

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[1] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2, 1925, p. 85.

Quarry ½ mile E.S.E. of Farmington

		Ft.	In.
Clypeus Grit	Typical ; *Clypeus ploti* Klein, *Terebratula globata* Auctt., etc. Seen in an opening above the quarry	—	—
	[*Non-sequence :* deposits of *truellei* (early) to *murchisonae* (late) hemerae (inclusive) absent]		
Lower Freestone (basal portion)	Oolite, flaggy ... ... seen for	0	6
	Marl	0	4
	Limestone	0	8
	Marl, yellowish	0	6
	Limestone, oolitic, irregularly bedded, bored ; surface of top layer waterworn and covered with oysters	4	0
' Yellow Stone '	Limestone, brown mostly, whitish locally seen for	12	0

Half a mile away and bearing E. 6°S. is the following small section[1] :—

Duckleston Quarry, Sherborne

		Ft.	In.
Clypeus Grit	Typical ; full of fossils ... seen for	7	6
	[*Non-sequence :* deposits of *truellei* (early) to *?murchisonae* (late) hemerae (inclusive) absent]		
?Lower Freestone	Oolite, hard, grey ; top bored ; surface level and covered with oysters	1	6
	Marl, yellowish	0	6
' Yellow Stone '	Limestone, yellowish, shattered ; seen for	4	0

The rock queried as Lower Freestone is a beautiful oolite, the even-sized white ooliths being closely crowded in a grey matrix. The rock is very hard and might be taken for Notgrove Freestone ; it is identical with a bed at Hill Barn Quarry, one and a half miles to the north, from which a single specimen of *Plectothyris fimbria* has been obtained.

According to Hull[2] ". . . on the north side of the valley opposite Sherborne . . ." there was the following section :—

Section at Sherborne

		Ft.
Ragstone	[Clypeus Grit] Rubbly oolite, with impressions of *Trigonia costata, Clypeus sinuatus, Terebratula globata,* with *Gresslya, Lima gibbosa,* etc.	—
Oolitic Freestone	[' Yellow Stone '] Yellow oolitic freestone becoming sandy towards the base, about	5
Upper Lias	[Scissum Beds] Yellow sandstone and sands	8
	[Upper Lias clay] Blue clay with *Ammonites walcottii*	—

The strata Hull mapped as Midford Sands in this area are Scissum Beds—Inferior Oolite. He said :[3] " At Sherborne we arrive at the south-eastern limit of these beds, but they form the banks, fifteen feet high, of a valley leading northward towards Clapton, in which I found a large ammonite (A. heterophyllus ? Sow.), 1 foot 8 inches in diameter." Buckman[4] has

[1] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2, 1925, p. 86.
[2] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 40.
[3] *Idem*, p. 30.
[4] ' On Certain Genera and Species of Lytoceratidae,' *Quart. Journ. Geol. Soc.*, vol. lxi, 1905, p. 147.

suggested that the ammonite referred to is either *Pachylytoceras phylloceratoides* S. Buckman or a species closely allied to it, the holotype of which came from the Northampton Ironstone (hemera *scissi*, presumably) of Spratton, Northamptonshire.

Typical Clypeus Grit is exposed in quarries one third of a mile south-west by south from Broadmoor Farm, south-east of Clapton (7 ft.), and near Northfield Barn (9 ft.), three-fifths of a mile north-east of Sherborne Church. The rock is full of specimens of *Clypeus ploti* Klein and *Terebratula globata* Auctt.

When the road between Windrush and Little Barrington was widened, three furlongs east-north-east of Windrush Church, Clypeus Grit was displayed resting on Upper Lias clay. Buckman represents the Moreton anticlinal axis as passing southwards about here.[1] East of this axis, rubble of Clypeus Grit is to be seen on the site of an old quarry in the allotments at Little Barrington—nearly a quarter of a mile south-west of the church; but east of this on the south side of the Windrush valley no exposures of Inferior Oolite rocks have been recorded.

The Rissington District.—This name is applied for convenience to the high ground in Sheet 235 that is situated east of the Vale of Bourton and north of the Windrush valley between Little Barrington and Taynton. Throughout this district, so far as can be ascertained, Clypeus Grit rests directly and non-sequentially on Upper Lias clay: Hull wrote:[2]—"At [Little] Rissington, where the [Midford or Cotteswold] sands are absent, we find springs bursting forth at the junction of this grit and the Upper Lias Clay . . ." He gave a section of the 'Clypeus Grit' Little Rissington (Clypeus Grit, 12 ft. 8 in.; unseen, about 4 ft.; Upper Lias clay) and observed[3] "Such is the general character of this subdivision over the high land extending from Icomb Camp to Burford; the thickness in the former locality being from 30 to 40 feet, and diminishing to more than one half at the latter."

The Clypeus Grit is well developed, typical and crowded with fossils. The finest sections are those on the hill east of Little Rissington, where—on the north side of the road—two quarries afford much the same section.[4]

Little Rissington Quarries

		Ft.	In.
Clypeus Grit	Rubbly Beds. *b*. Limestones, rubbly; *Clypeus ploti* Klein, *Terebratula globata* Auctt., *Berenicea sp.* (on *T. globata*), *Pholadomya murchisoni* (J. de C. Sowerby), *Pleuromya goldfussi* (Lycett), *Camptonectes lens* (J. Sowerby), passing down into 'Massive Beds.' Limestones, more massive ... ... seen for	6	0
	Rubble	0	5
	Limestone, coarse, oolitic; occasional specimens of *Terebratula globata* Auctt., *Entolium demissum* (Phillips)	2	0
	Limestone rubble; *Clypeus ploti* Klein very common (4 to 8 in. diam.)	0	6
	Limestone, massive, oolitic	2	8
	Rubble; *Clypeus ploti* Klein...	0	3
	Limestone, massive, oolitic seen for	1	10

[1] *Quart. Journ. Geol. Soc.*, vol. lvii, 1901, pl. vi.
[2] 'Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 47.
[3] *Idem*, p. 47.
[4] Richardson, L., 'The Inferior Oolite and Contiguous Deposits of the District between the Rissingtons and Burford,' *Quart. Journ. Geol. Soc.*, vol. lxiii, 1907, p. 441.

Other quarries displaying Clypeus Grit are situated near the Merrimouth Inn, Fifield (p. 38); at Great Rissington[1]; near the Lodge about four-fifths of a mile east-north-east of Great Rissington; and three-eighths of a mile north of Taynton Church.

The quarry at Great Rissington, on the east side of the village, is now mostly overgrown, but the section displayed in it was described by the writer in 1907. At that time he had not identified the Chipping Norton Limestone in the district, so the record is repeated here with the amended classification of the beds.[2]

Quarry at Great Rissington

		Ft.	In.
Chipping Norton Limestone	Limestones, brownish, black-speckled ...	—	—
	Limestones, rotten-looking, shelly	—	—
Roundhill Clay	Clay, greenish-grey, with a band of limestone full of *Ostrea acuminata* J. Sowerby (3 to 6 in.)	1	0
Clypeus Grit	Rubbly Beds. *a.* Limestone, '*Globata*-Bed'; *Terebratula globata* Auctt., and *Clypeus ploti* Klein	0	6
	b. Limestones, rubbly; *Clypeus ploti* Klein, *Terebratula globata* Auctt., and *Pholadomya murchisoni* J. de C. Sowerby; about	8	0
	'Massive Beds.' Limestones, more massively bedded; *Clypeus ploti* Klein, *Terebratula globata* Auctt. ... ... seen for	12	0

Boreholes commencing in Great Oolite that have reached the Inferior Oolite have been made in the Leach valley near Sheep Bridge,[3] and at Ewepens, Cirencester.[4]

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[1] *Idem*, pp. 440, 441.

[2] See also L. Richardson, 'The Country around Moreton in Marsh' (*Mem. Geol. Surv.*), 1929, p. 83.

[3] See p. 112; also L. Richardson, 'The Wells and Springs of Gloucestershire' (*Mem. Geol. Surv.*), 1930, p. 90.

[4] See p. 110; also L. Richardson, *ibid.*, p. 190.

CHAPTER IV

FULLERS' EARTH

The division-line between the Inferior Oolite and Fullers' Earth Series is drawn at the top of the Clypeus Grit : throughout the district between Oxford and the English Channel near Bridport, Dorset, it has been found that it is best to regard the close of the hemera *schloenbachi* as the end of the Inferior Oolite epoch. The upper limit of the Fullers' Earth Series is drawn above the *Rhynchonella*-Bed, which comes immediately above the deposit (*Ostrea acuminata*-Limestones) in which *Ostrea* (*Liostrea*) *acuminata* J. Sowerby last appears in abundance. The *Rhynchonella*-Bed is also taken for the present as constituting the top bed of the Stonesfield Slate Series. The constituent beds of the Fullers' Earth Series are shown in the table on p. 36.

At the time of publication of the Old Series Geological Survey map and the explanatory memoir it was held that the Fullers' Earth thinned out in the neighbourhood of Little Barrington and was absent from the country to the east and from the Rissington country to the north. At that time the interest attaching to the rock now called the Chipping Norton Limestone had not been realized, and along with the locally underlying Roundhill Clay and more widespread overlying Upper Estuarine Clay it was included in the Great Oolite. Now, however, it is known that the Chipping Norton Limestone is well developed (up to about 12 ft. in thickness) in the Rissington country in which it is succeeded by heavy tough Upper Estuarine Clay. The Chipping Norton Limestone, however, has not a wide extent in the present district : it occurs along the south side of the Windrush valley between the county boundary and Burford (Sheet 236), but attenuates and is overlapped to the west, while it likewise becomes attenuated and is overlapped, here by the Taynton Stone, on the northern outskirts of Barrington Park. Traces of the rock occur in the neighbourhood of Aston Blank, and there may be some representative of it in the vicinity of the Cleeve Hill synclinal axis in cuttings on the railway between Withington and Chedworth ; but elsewhere in the district it is absent.

With regard to the clays : (1) definitely Upper Estuarine Clay has been observed resting non-sequentially on the Clypeus Grit in the first railway-cutting west of Notgrove Station[1] ; (2) what

[1] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 75.

FULLERS' EARTH SERIES

Geol. Surv. Map, N.S., Sheet 235		Sheet 217
a Mid Cotteswolds (*pars*)	*b* Rissington District	(Complete sequence)
Rhynchonella-Bed, and *Ostrea acuminata*- Limestones being the top beds of the Stonesfield Slate Series	No definite information, but probably all these deposits are absent from the district.	*Rhynchonella*-Bed *O. acuminata*-Limestones being the top beds of the Stonesfield Slate Series
Fullers' Earth Clay		Fullers' Earth Clay
?Traces locally of Upper Estuarine Clay	Upper Estuarine Clay	Upper Estuarine Clay
[Position of Neaeran Beds]	[Position of Neaeran Beds]	Neaeran Beds (trace at Bolton's Ground Quarry[1])
Chipping Norton Limestone (traces locally)	Chipping Norton Limestone (? up to 12 ft.)	Chipping Norton Limestone
?	Roundhill Clay	Roundhill Clay

[1] 'The Country around Moreton in Marsh' (*Mem. Geol. Surv.*), 1929, p. 99.

is probably Upper Estuarine Clay was seen resting on Clypeus Grit in a pipe trench about half way between Hartley Cottages and Hartley Bottom well on the Leckhampton Hill mass; and (3) what is probably true Fullers' Earth is displayed resting on Clypeus Grit in the side of a sunken track at Bull Banks, near Duntisbourne Abbots.

The true Fullers' Earth, that is, the Fullers' Earth less any local occurrence of Upper Estuarine Clay, probably—in the writer's opinion—attenuates (in the strict sense of the word) from south-west to north-east, and in the area adjacent to the western side of the Vale of Bourton locally underwent some erosion previous to the deposition of the Great Oolite.

Thicknesses of the Fullers' Earth are:—at Kemble Junction (boring) 2¼ miles south-south-east from Coates, 73 ft.[1]; Ewepens (boring), Cirencester, apparently 69¾ ft.[2]; at Miserden, about 2 miles west-north-west from Duntisbourne Abbots, according to an estimate of Edwin Witchell, 30 ft.[3]; at Bull Banks, about 1 mile west by north of Duntisbourne, about 24 ft. (seen in the side of a sunken track with a median 3-in. *Ostrea acuminata*-Limestone); at Pen Hill, near Colesborne, according to Hull,[4] "probably not less than 60 feet"; and near Chedworth, according to H. B. Woodward, "about 50 feet."[5] William Lonsdale was of opinion that the Fullers' Earth thinned out in the neighbourhood of Little Barrington.[6]

The presence of the Fullers' Earth is readily detected by the clayey nature of the soil to which it gives rise and by the springs that it throws out from the base of the succeeding Great Oolite. The formation is now nowhere adequately exposed in the district for the student of the series to obtain the necessary facts on which to base his conclusions as to the correlation of the deposits present; but judging by the occasional occurrence of layers of argillaceous limestone largely made up of the valves of *Ostrea acuminata* J. Sowerby, and the presence of this oyster in the clays as far to the north-east as the Roundhill railway-cutting near Bourton on the Water,[7] it appears likely that the true Fullers' Earth present in the district is a continuation of that in the Minchinhampton district, near Stroud, which in turn is a continuation of that succeeding the Fullers' Earth Rock in the vicinity of Bath.

The Stonesfield Slate Series is described, for convenience, in the chapter dealing with the Great Oolite.

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[1] 'Wells and Springs of Gloucestershire' (*Mem. Geol. Surv.*), 1930, p. 107.
[2] *Idem*, pp. 190, 191.
[3] 'The Geology of Stroud and the Area drained by the Frome,' 1882, p. 69.
[4] 'Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 53.
[5] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 245.
[6] *Proc. Geol. Soc.*, vol. i, 1826-33, p. 414.
[7] 'The Country around Moreton in Marsh' (*Mem. Geol. Surv.*), 1929, pp. 112, 113.

DETAILS

The outcrop of the Chipping Norton Limestone has been mapped by Mr. Dines. In the Rissington country, north-east of the Windrush valley, although the ground was locally covered with long grass and crops, adequate evidence was obtained for determining approximately the boundary lines, except in the vicinity of the old Taynton Quarries where the outcrop shown on the map is conjectural and probably masked by slips. South of the Windrush Mr. Dines observed "undoubted Chipping Norton Limestone in what was presumably a small quarry at Upton, half a mile west of Burford; in a road bank a little west of this point; and in fields at about half a mile farther west. Half a mile still farther to the west nothing like Chipping Norton Limestone was visible, but here again the fields were all grass and observations were confined to ditches, etc. It is probable that the Limestone near Upton is not more than 5 or 6 ft. thick, attenuates to the west, and dies out where shown on the map." "Around Aston Blank," according to Mr. Dines, "nearly all the fields are grass. Some Chipping Norton Limestone was observed in a sunken lane a quarter of a mile east of the village, and also some pieces in a ploughed field at about half a mile to the south-south-east. At a little over a quarter of a mile west-south-west from the village a shallow trench up the slope of the hill for a newly-installed ram revealed on the shoulder of the hill (just where the slope becomes less steep owing to the Fullers' Earth) Chipping Norton Limestone that probably has a total thickness of about 4 ft."

The sequence from the Clypeus Grit upwards to the Chipping Norton Limestone was once well displayed in a now mainly overgrown quarry above Great Rissington: it was (see also p. 34):—Clypeus Grit, 20½ ft. seen; Roundhill Clay with a band replete with specimens of *Ostrea acuminata* J. Sowerby, 1 ft.; Chipping Norton Limestone. This sequence, however, can still be seen at two quarries in the district, namely, in the quarry north-east of the Merrimouth Inn, Fifield, and in that three-quarters of a mile west by north of the Inn.

Quarry near the Merrimouth Inn, Fifield

		Ft.	In.
Chipping Norton Limestone	Limestone, grey, sandy, compact, with black specks, splitting up into rough tile-stones and weathering shaly at the base; seen for	6	0
Roundhill Clay	Marl, clay, and limestone rubble	0	6
Clypeus Grit	Limestone, massive, oolitic, with few fossils except in the top portion (= Rubbly Beds) in which *Terebratula globata* Auctt. is abundant; *Clypeus ploti* Klein; seen for	4	6

Excellent exposures of Chipping Norton Limestone capped with traces of Upper Estuarine Clay are those in quarries nearly 1½ miles north-east by east, 1⅛ miles north-east, 1½ miles north-north-east, and a little over three-quarters of a mile east-south-east from Great Rissington Church, and 5 furlongs north-east of Taynton on the left hand side of the road leading up from the village to Taynton Down.

Quarry N.E. of Taynton

		Ft.	In.
U. Est. Clay	Clay, blackish ... ... up to	2	0
Chipping Norton Limestone	Limestone, compact	0	5
	Limestone, 'tiley'	2	9
	Marl, brownish, stony; *Ostrea acuminata* J. Sowerby	0	8
	Limestone, very hard, grey, sandy to the touch; top waterworn with adherent oysters ... ... seen for	5	0

CHAPTER V

GREAT OOLITE AND FOREST MARBLE

The Great Oolite occupies a larger area in the district than is indicated on the map, since the uppermost subdivision, namely, the Kemble Beds, has been included (for reasons given on p. 50) in the Forest Marble Series.

The upper limit of the Great Oolite in this district is often difficult to determine and the lower limit is nowhere exposed. The main subdivisions, in descending order, are :—

Kemble Beds
White Limestone
Marly Beds
Taynton Stone
Stonesfield Slate Series

All five subdivisions are clearly exposed, exhibiting their typical characters, in the Hampen railway-cutting between Andoversford and Notgrove just outside this district to the north.[1]

Stonesfield Slate Series and Taynton Stone

For the present the *Rhynchonella*-Bed (see p. 36) is taken as the top bed of the Stonesfield Slate Series, but a better developed, more readily recognized, and wider spread deposit in the Northleach district consists of the limestones and associated marl which are packed with specimens of *Ostrea acuminata* J. Sowerby.

When Hull examined this district some seventy-five years ago for the production of the Old Series Geological Survey Map, Sheet 44, and the explanatory memoir, he had not the advantage of the fine section in the railway-cutting at Hampen and was unaware that the Stonesfield Slate Series was succeeded by freestone —the Taynton Stone. Hull observed[2] : " This is an exceedingly variable series of beds, being composed in some places of sandy flags, slates, and blue limestones, and in others, of white oolitic freestone, with much false bedding, and not unlike the freestones of the Inferior Oolite. Where these beds become sandy and fissile, as at Sevenhampton Common, Througham [near Bisley, near Stroud], Eyeford, and Naunton, they are capable of being split into slates . . . ; on the other hand, where they assume a highly

[1] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, pp. 102-106.
[2] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 53.

oolitic type, as at Farnington [see p. 42 of the present memoir], Windrush and Taiton Downs, an observer would scarcely imagine them to be on the same geological horizon with the beds in the former localities." Although Hull was in error in his conclusion that the Stonesfield Slate Series passed laterally into the Taynton Stone, he was correct in his remark that it undergoes considerable changes in its lithic structure.

Where the Stonesfield Slate Series is fully developed in the district to the north of the present area it is separable (in descending order) into :—

Rhynchonella-Bed[1]
Ostrea acuminata-Limestones
Sevenhampton Marl
Ragstone
' Slate ' Bed

In the present district around Salperton, Hazleton, and Turkdean, the Stonesfield Slate Series is in general very similar to the Series as developed in the region to the north, but the Sevenhampton Marl, *Ostrea acuminata*-Limestones, and *Rhynchonella*-Bed, are more irregularly developed—the first-named (as in the district to the north) especially so, being, as a rule, absent. Representatives of one or both of the other two, however, are usually present. Around Compton Abdale, Northleach and Farmington, the Ragstone portion of the Series has undergone a change—it has become a more evenly oolitic limestone and locally a good freestone.

The contemporaneity of this oolitic limestone (which is locally a good freestone) with the main mass (Ragstone) of the Stonesfield Slate Series is proved by the occurrence at the Compton Quarry (p. 42), at the quarry near the Isolation Hospital, Northleach (p. 42), and at the Farmington Stone Quarries (p. 42), of the prolific *Ostrea acuminata*-Limestones and associated marl above. Supplementary evidence is the occurrence at the Downs Quarry—No. 1, Salperton[2]—as well as at the quarry near the Isolation Hospital, Northleach, and the Farmington Stone Quarries, of a bored limestone bed immediately below the *Ostrea acuminata*-Limestones that points to a somewhat widespread erosion. Thus a deposit with abundant *Ostrea acuminata* overlies the ' Farmington Freestone,' and—as will be noticed later—one with locally abundant *Ostrea sowerbyi* Morris and Lycett overlies the Taynton Stone.

The ' slate ' bed that yields the well known tile-stones in the Sevenhampton and Eyford districts occurs at or near the base of the Stonesfield Slate Series, and the actual fissile bed is rarely above a foot in thickness. In the present district tile-stones have been worked at the following places :—alongside the main road

[1] This bed is tentatively taken as the top bed of the series.
[2] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 109. Here the bed consists of rolled and bored pebbles embedded in the basal portion of the *Rhynchonella*-Bed.

about 2 miles west by north of the Puesdown Inn[1]; half a mile east by south of Compton Abdale; Chedworth[2]; Rendcomb,[1] and Pen Hill, near Colesborne. None of the pits is now ' in work ' (see also p. 105).

The Taynton Stone, as a rule, is not characteristically developed in this district to the west of the Coln valley, but to the east of Northleach it is prominently developed as an excellent freestone.

Marly Beds

These beds were regarded by Hull as constituting the lower portion of his ' Upper Zone ' of the Great Oolite, of which the upper portion is the White Limestone. He said: " The Upper Zone of the Great Oolite is so well marked throughout the whole of the district, that there is no difficulty in drawing a boundary line at its base. It is generally introduced by beds of marl . . . "[3]

The occurrence of readily recognizable beds of marl (Marly Beds) immediately below the White Limestone is not so regular as the remark made by Hull would lead one to suppose. The Marly Beds are most typically developed and clearly displayed in the railway-cutting at Hampen, Sheet 217, between Notgrove and Andoversford stations.[4] The lower portion passes down into limestone, and in quarry-sections where such is the case it will be readily understood that it may be difficult to decide exactly where the Taynton Stone ends and the Marly Beds begin. The subdivision, however, may usually be detected by the occurrence of a marl or clay bed rich in specimens of *Ostrea sowerbyi* Morris and Lycett: such a bed has been observed in the railway-cutting at Hampen; in that at Stony Furlong, near Chedworth; at Pinswell, near Chedworth; near North Cerney, and at High Cross, Elkstone.

Details: Stonesfield Slate Series, Taynton Stone and Marly Beds

Very similar sections showing the *Rhynchonella*-Bed and *Ostrea acuminata*-Limestones overlying oolitic, shelly, flaggy limestones, appear in quarries about two-fifths of a mile south by west of Hazleton and three-quarters of a mile to the north-north-west—between Hazleton Grove and the tumuli; while in quarries near the tumuli, and in one three-tenths of a mile south-east by east of Salperton, connexion with the Taynton Stone is displayed.

About 1¼ miles east by south of Compton Abdale is a quarry in which the following section was measured:—

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[1] Woodward, H. B., ' The Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 296.
[2] *Idem*, p. 484.
[3] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 61.
[4] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 105.

Compton Quarry, near Compton Abdale

	Ft.	In.
RHYNCHONELLA BED. Marl, yellowish, and stone ; *Kalli-rhynchia sp., Modiola sp., Ostrea acuminata* J. Sowerby, *Anabacia porpita* (Smith) ... ... up to	2	0
OSTREA ACUMINATA LIMESTONES. Typical *Ostrea acuminata* J. Sowerby	0	4
Marl, brown, clayey ; *Pleuromya sp.*	0	10
Limestones, beautifully oolitic, flaggy here and there seen for	15	0

A quarry a little over 1 mile north by west of Turkdean, now overgrown, once displayed the sequence from the ' Slate ' to the *Rhynchonella*-Bed.

A quarter of a mile north-west by west of the Isolation Hospital to the north of Northleach, and on the east side of the road to Leygore and Turkdean, is a disused quarry presenting a useful section as under :—

Quarry near the Isolation Hospital, Northleach

	Ft.	In.
OSTREA ACUMINATA LIMESTONE, packed with specimens of *Ostrea acuminata* J. Sowerby...	0	4
Clay, yellowish-brown, marly, also packed with *Ostrea acuminata* J. Sowerby	0	8
SEVENHAMPTON MARL. Limestone, dense, fine-grained, sandy, riddled with borings—some crypts of *Lithophagi* (*cf.* bed at Salperton Downs, p. 40, and the Farmington Stone Quarries, below)	0	4
Marl, pale yellow, and stone	0	8
RAGSTONE. Here, limestone, white oolitic, with much shell debris, locally false-bedded ; occasional large crushed Rhynchonellids ... ... seen for	8	0

A mile to the north-east of the hospital is the old Fosse Quarry, now known as the ' Farmington Stone Quarries.' It is the only quarry in the district that is being worked continuously. The sequence here is as follows :—

Farmington Stone Quarries

	Ft.	In.
Taynton Stone :		
Limestone, flaggy, oolitic ... ... seen for	2	0
Stonesfield Slate Series :		
? RHYNCHONELLA BED. Marl, yellow, with layers of clay of variable thickness	1	2
OSTREA ACUMINATA LIMESTONES. Two—packed with small specimens of *Ostrea acuminata* J. Sowerby ; *Placunopsis socialis* (Morris and Lycett)—with clay parting	0	8
? SEVENHAMPTON MARL. Marl, yellow, locally clayey and stony—traces of a bored bed (as at Salperton Downs and in the quarry near the Isolation Hospital) occur ; typical *Ostrea acuminata* J. Sow. plentiful ... up to	1	3
FARMINGTON FREESTONE. Freestone, mostly massive-bedded, oolitic, shelly—the ooliths and shell debris occurring in wisps. The top stratum is hard and full of oysters and also contains a Rhynchonellid, *Lima cardiiformis s.l., Plicatula sp.* ... ... seen for about	17	0

Locally clay caps the section, but it would appear to be a product of the weathering of the clays in which occur the *Ostrea acuminata*-Limestones. Further particulars of this quarry and of its products are given on p. 104.

The mansion at Sherborne Park is built of Taynton Stone obtained from a quarry in the park, of which Hull gave a sketch and the statement that " The quarry shows a gentle synclinal, which has the effect of bringing in the marly beds, which invariably form the base of the upper zone of the Great Oolite in this district."[1]

The once famous Windrush Quarry is situated a quarter of a mile south-west of Windrush Church. The stone was ' mined,' but the quarry has been abandoned now for many years and the entrance to the mine is blocked up. The record given by William Lonsdale[2] differs considerably in detail from that noted by Hull,[3] which is as follows :—

Section at Windrush Quarries

	Ft.	In.
[White Limestone :]		
1. Loose white argillaceous limestone	1	6
[Marly Beds :]		
2. Parting of marly shale	0	6
3. Thin-bedded brown calcareous sandstone	0	8
4. Yellow slaty marl	0	8
5. Brown calcareous sandstone, very fossiliferous ...	1	0
6. Yellow, brown, and white sandy marl, with a parting of stone	10	0
7. Hard sandy limestone, slightly oolitic	2	6
8. Sandy oolite (soft)	2	6
9. Marls and shales	2	6
[Taynton Stone :]		
10. Fine white oolite [freestone] coming out in large blocks ... ... more than	7	0

According to Woodward[4] : " The thickness of the workable stone at Windrush does not exceed 11 feet : but there is an alternation of shelly rock (Rag) and Freestone. The freestone is of good quality."

Just under one mile south-east by south of Sherborne Church, on the east side of the road, is a quarry the section in which was accurately described by Woodward, who gave its location as " south-east of Sherborne, and north of the fifth milestone on the high road between Northleach and Burford."[5] It is as follows :—

Hill Barn Quarry, near Sherborne

	Ft.	In.
Stonesfield Slate Series :		
Limestones, coarsely flaggy, locally false-bedded, oolitic, with yellowish brown marly layers—the whole replete with *Ostrea acuminata* J. Sowerby. In one place the the oyster-limestones and marl partings pass into a brown marly clay devoid of oysters	8	0
——————— [*level line*] ———————		
Limestones, obliquely bedded, oolitic ; coarse and fine oolite in pale buff and brown bands ... seen for	6	0

The oyster-limestones above the ' level line ' *may be* equivalent to the *Ostrea acuminata*-Limestones ; the limestones below, to the Ragstones.

Taynton Stone has been ' mined ' in a quarry to the north-west of the New Inn, Little Barrington, and it is understood that part of the ' mine ' runs beneath the inn. Particulars obtained from the main quarry face (now almost

[1] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 56.
[2] ' Report of the Survey of the Oolitic Formations of Gloucestershire,' *Proc. Geol. Soc. London*, vol. i, 1826-33 (paper communicated Dec. 19th, 1832), p. 415.
[3] *Ibid.*, p. 57.
[4] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 301.
[5] *Idem*, p. 300.

hidden), small exposures, an old quarry to the north-east, and another to the north (close to the road to Little Barrington), confirm the sequence noted by Hull at Windrush.

Quarries near the New Inn, Little Barrington

Old main quarry

	Ft.	In.
White Limestone:		
1. White limestone, ' flinty ' ; *Montlivaltia sp.* ...	1	0
Marly Beds:		
2, 3, 4. Rubbly, marly limestone and marl	1	10
5. Limestone, the upper part hard, the lower part marly with abundant *Modiola imbricata* J. Sowerby, *Trigonia pullus* J. de C. Sowerby, *Protocardia sp.* ...	1	0
6. Gap: ample indications of clayey marl	?10	0
[? 7. obscured	2	6]
Old quarry to the N.E., near field gate		
8. Limestone, coarse, shelly, oolitic, white seen for	2	0
9. Oyster Marl. Marl, clayey, pale brown and grey; abundant *Ostrea sowerbyi* Morris and Lycett; *Kallirhynchia concinna* (J. Sowerby) (rare)	2	6
Taynton Stone:		
10. Oolite, fine, yellowish: ... ... seen for	4	0
Old quarry a little to the N., by the road side		
Oolite	—	—

The Taynton Stone, bed 10, is at present (1930) being worked for building stone—and takes a good dressing—in a quarry 7 furlongs west of the church, Little Barrington, where it is exposed to a depth of 11 ft., with the Oyster Marl (bed 9) above.

Between the last quarry and Little Barrington traces of clay (Fullers' Earth) have been observed by the writer in the roadside banks, and rubble of Clypeus Grit on the site of an old quarry (now a garden) lower down on the east side of the road, but none of a ' slaty ' bed or of Chipping Norton Limestone.

In the past Taynton Stone has been extensively worked on Taynton Downs but now there is no quarry in work (see also p. 104). It is obvious that locally the rocks have slipped a good deal down the valley side. The last quarry from which the stone was drawn is that immediately north-west of the ' Q ' of ' Quarries ' on the map.[1] The following particulars were obtained (in 1929) in a long-disused quarry, at the eastern extremity of the plantation at the head of the comb, two-fifths of a mile north-east by east of this last quarry in work:—

Taynton Quarries

	Ft.	In.
White Limestone:		
White Limestone rubble—somewhat slipped ... say	2	6
Marly Beds:		
Marly clay, greenish-grey and white, becoming yellow and stony towards the base; in the basal portion *Lucina bellona* d'Orbigny is fairly common	4	0
Limestone, white-brown, flinty; *Nerinea sp.*	2	4
Clay, green and brown	1	2
Limestone, white, marly	1	0
Clay, sandy, yellow	2	0
Clay, sandy, grey	2	0
[*Gap*] ... ... about	6	0
Taynton Stone:		
Freestone, shelly, false-bedded ... ... seen for	20	0

[1] Ordnance Survey, 1905 Edition.

In the last quarry in work—referred to above—the Taynton Stone is exposed to a depth of 19½ ft., and is seen to be yellowish freestone, on the whole massive-bedded with practically no layers of marl, strongly oolitic, with, locally, shelly lenticles containing mostly small fossils as in the case of the equivalent rock in the railway-cutting at Hampen, near Andoversford.

Three-fifths of a mile south by west of Fifield, on the east side of the Stow-Burford road (just south-east of the spot level 577), is a quarry showing the upper part of the Taynton Stone and the basement bed of the Marly Beds[1] as under :—

Quarry near Fifield

	Ft.	In.
Marly Beds :		
Oyster Marl. Marl with abundant *Ostrea sowerbyi* Morris and Lycett, *Kallirhynchia deliciosa* S. Buckman ...	5	0
Taynton Stone :		
Limestone, massive, oolitic ... ... seen for	10	0

Higher beds, white limestones with *Nerinea spp.*, etc., and associated green clay, belonging to the White Limestone subdivision, are seen in the ' Tangley Section ' (p. 84).

Exposures of the Lower Division and Marly Beds to the south and south-west of Northleach will now be considered.

The rocks belonging to the Lower Division in the cuttings at Chedworth Station are much disturbed owing to slipping on the valley side and are mainly overgrown. Near the bottom of the west side of the northern portion of the Stony Furlong railway-cutting is a bed of clay—Harker's organic bed—with abundant *Ostrea sowerbyi* Morris and Lycett, that probably represents the *Ostrea sowerbyi* or Oyster Marl of the Marly Beds (see also p. 63). The beds between it and the Fullers' Earth would appear to be about 24 ft. thick.

At Pinswell, half a mile east-south-east of Woodlands (about 1¾ miles west-north-west of Chedworth), is a quarry that was noticed by the writer in 1904,[2] but it has, at some time in the interval between that date and the present, been worked deeper. The beds which come below the White Limestone, are as follows :—

Pinswell Quarry

	Ft.	In.
Marly Beds :		
Oyster Marl. Marl, brownish ; abundant *Ostrea sowerbyi* Morris and Lycett	1	0
Limestone, whitish, rubbly, and marl ; at 14 in. above the bed below is a layer full of *Nerinea spp.* ; *Natica sp.*, *Ostrea sowerbyi* Morris and Lycett rare...	2	9
Limestones, white, fine-grained ; *Nerinea sp.*	3	9
Marly limestone and marl, cream- and yellow-streaked, sandy to the touch ; *Pinna* cf. *ampla* J. Sowerby, *Placunopsis socialis* Morris and Lycett, *Pleuromya sp.*	3	0
? Taynton Stone :		
Limestone, white, oolitic—poor hard freestone ; seen for	6	0

Freestone (16 ft.), below the level of the White Limestone, has been worked in a quarry south of Greenmeadow.

A quarry at North Cerney, near the road to Foss Cross north-east of the Smithy, gave the following section :—

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[1] Richardson, L., ' Excursion to Bourton-on-the-Water . . . ,' *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 1, 1907, p. 28.

[2] A ' Handbook to the Geology of Cheltenham . . . ,' 1904, p. 170.

Quarry at North Cerney

	Ft.	In.
Marly Beds (? all):		
Limestone, grey, compact, level top, much bored ...	0	10
Marl, yellowish	0	6
Limestone, grey, compact, and marl	0	10
Marl, yellowish; *Kallirhynchia concinna* (J. Sowerby), *Anabacia porpita* (Smith)	0	10
Limestone, brown, fine-grained	0	8
Oyster Marl. Marl, brownish; *Ostrea sowerbyi* Morris and Lycett (*cf.* top bed at Pinswell)	2	4
Limestone, yellowish, marly, slightly oolitic, with marl partings ... ... seen for	5	0

On the south-eastern side of Pen Hill, near Colesborne, close to the farm west of Lincombe Banks, is an old quarry in the Stonesfield Slate Series. Details are as follows:—

High Cross Quarry, near Elkstone

	Ft.	In.
Marly Beds:		
Limestone, whitish, with yellow ooliths ... seen for	1	8
Oyster Marl. Marl, clayey; abundant *Ostrea sowerbyi* Morris and Lycett...	2	6
Lower Division:		
Pennant.		
(*a*) Limestones, grey, fine-grained, sandy, thin-bedded in the upper portion with marl partings	2	6
(*b*) Limestone, similar	1	6
(*c*) Marl, sandy	0	4
(*d*) Limestone, similar	1	5
(*e*) Marl, yellow, clayey, sandy	1	0
Weatherstone. Limestone, grey, fine-grained, sandy in the upper portion, slightly oolitic in the lower; shelly, now seen, 2 ft.; formerly	7	0

There is a non-sequence between the Oyster Marl and Pennant. Locally, the Marl occupies a hollow scooped out of the beds below: generally it rests on bed (*a*), locally, however, it crosses the edges of (*a*), (*b*) and (*c*), to rest on (*d*), and the rock on which it rests is bored. A mile to the south of this quarry, or 1½ miles south of Elkstone, is another quarry displaying much the same beds.

Near the 10th milestone from Gloucester on the Ermin Street, in Gloucester Beeches, is a quarry in "the Lower Beds of the Great Oolite,"[1] as under:—

Smith's Cross Quarry, near Elkstone

	Ft.	In.
Lower Division:		
Pennant.		
(*a* to *d*) Limestones, grey, fine-grained, in comparatively thin beds with marl partings—the thickest layers being in the lower portion ... ... seen for	5	0
(*e*) Marl	0	2
Weatherstone. Oolite, massive, false-bedded, shelly ...	12	0
Limestones, with partings of brown clay	—	—

According to a quarryman there are no shells in the Pennant here.

About one-third of a mile north-east by east of Beechpike an old quarry has been re-opened in the Weatherstone and has a face 12 ft. in depth. Very similar beds are quarried at Daglingworth—in a field close to the road to Grove Hill and the Ermin Street—as will be seen by the following section:—

[1] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 288.

Quarry at Daglingworth

	Ft.	In.
Lower Division :		
Limestone, yellowish, oolitic, obliquely bedded ; seen for	3	0
Marl, making a regular line	0	2
Limestone, yellowish and locally brownish-grey, oolitic ; in places sandy, in others obliquely bedded, but massive-bedded in the lower portion. The more sandy beds are very shelly; *Chlamys vagans* (J. de C. Sowerby), *Ostrea*, etc., lignite. Can be dressed for building purposes ... ... seen for	6	0

White Limestone

The White Limestone is the most interesting of the five subdivisions of the Great Oolite in this district—petrologically as well as palaeontologically. Certain of its beds are hard, almost ' flinty,' white limestones—weathering to a degree of whiteness, as remarked Hull,[1] " scarcely surpassed by the chalk." This facies, however, is not persistent : its occurrence cannot be relied on to indicate contemporaneity for the beds exhibiting it. Individual strata may be in one place oolite, and in another, ' flinty ' white limestone or Dagham Stone (see p. 59), while variable beds of limestone and marl are known to pass laterally, *en bloc*, into masses of hard, white limestone. Nevertheless, there are thick beds of white limestone that are persistent over large areas and these occur on the horizons of the *Ornithella-* and *Lucina*-Beds (see Fig. 2, p. 61). The Aldgrove and Stony Furlong railway-cuttings between Cirencester and Chedworth show the white ' flinty ' limestones at these horizons, but before the railway-cuttings were made, in the days of Hull, it would appear that it was concluded that only one block occurred and that it was about 10 ft. thick. " This limestone," remarked Hull, " is generally very hard, and along the Cheltenham and Oxford road produces the best available road material."[2] (Plate IVB).

The constituent deposits of the White Limestone are, as a rule, impersistent : marked differences in details of descriptions of beds in the same quarries may occur in the records made by independent observers especially if their visits are separated by any length of time. And unfortunately the fossil beds are very impersistent and usually consist of marl. However, the horizons at which certain fossils occur have been noted, and the remarks made in the descriptions of the railway-cuttings in the vicinities of Foss Cross and Chedworth (pp. 62, 63), and the generalized section, given on page 61, with its statement of horizons at which certain distinctive fossils have been obtained, will contribute to the progress in the correlation of the individual beds of the White Limestone subdivision.

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[1] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 61.
[2] *Idem*, p. 61.

Evidence that is accumulating points to flexing and erosion of the rocks previous to the deposition of the Kemble Beds. In other words the Kemble Beds do not throughout the district rest on the same stratum of the White Limestone : at Leach Bridge, near Aldsworth, higher White Limestone strata are present than at The Sisters Quarry, near Baunton, which—it is interesting to note—is nearer the Birdlip anticlinal axis of weakness.

Certain beds in the White Limestone subdivision that are well known locally are the ' Dagham Stones.' Typical ' Dagham Stone ' is a hard, white, sparsely oolitic limestone with irregular tubiform perforations that run in all directions (see Pl. IVA). It is a very effective rockery stone and is to be seen in many old rockeries in, and in the neighbourhoods of, Cirencester and Tetbury. The 'Stone ' may be met with on at least five horizons; but as a particularly good bed of it, which occurs at or near the surface on what was until its enclosure Dagham or Daglingworth Downs, could be readily got for rockery purposes, and was widely distributed, it obtained the name ' Dagham Stone.'

The origin of the perforations is doubtful, but, in the majority of cases, I incline to the opinion that they are due to the removal of the looser material of a deposit that has been locally hardened by segregation of, or by unequal cementation by, infiltrated carbonate of lime. In some cases the perforations may be due to the occurrence of branching corals in the limestone, the replacement of these by calcite, and the removal of the calcite and the enlargement of the cavities by percolating water.

S. P. Woodward[1] thought that ' Dagham Down Stone ' " must have originally enveloped a continuous bed of sponges, or something of the kind, for now the rain eats into it irregularly, leaving holes such as one could make with the fingers in dough." J. Lycett[2] attributed the irregular holes " to the forcible escape of gases from beneath while the stratum was of a soft or pasty consistence "; Allen Harker[3], to the action of humic acid; while Edwin Witchell[4] remarked that the probable explanation was " that the calcareous matter was deposited round soft substances which have been since dissolved or otherwise removed, and through the labours of boring animals when the surface of the limestone was the floor of the sea." In H. B. Woodward's[5] opinion " The most reasonable explanation seems to be that the soft calcareous mud was penetrated by burrowing organisms, which have left no other traces of their former presence in the now indurated deposit, than the irregular lines of weakness caused by their burrows. These have been subsequently acted upon both superficially and underground, by acidulated waters."

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[1] In Miss E. Hodgson's paper on ' The Moulded Limestones of Furness,' *Geol. Mag.*, 1867, p. 405.

[2] ' On the Mineral Character and Fossil Conchology of the Great Oolite, as it occurs in the neighbourhood of Minchinhampton,' *Quart. Journ. Geol. Soc.*, vol. iv, 1848, p. 185.

[3] *Proc. Cotteswold Nat. F. C.*, vol. ix, 1890, p. 316.

[4] ' The Geology of Stroud and the Area drained by the Frome,' 1882, p. 78.

[5] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 287.

Between the White Limestone and the Cornbrash in this district is a series, as stated by Hull, "extremely variable in composition and irregular in its stratification." On the Old Series Geological Survey Map, Sheet 34, this series is represented as Forest Marble. This representation has been continued on the New Series Map, because it is considered that it is the most appropriate for the district. This district is essentially agricultural, and one in which, therefore, information as to the leading types of soils is desirable, and this plan of representing the distribution of all the beds between the White Limestone and Cornbrash by one colour indicates that in the area thus coloured soils are variable—brashlands with 'veins' and 'pockets' of clay of greater or lesser extent.

For geological purposes, however, the intervening beds are separable into:—

Forest Marble	Wychwood Beds
	Bradford Clay
Great Oolite	Kemble Beds

Kemble Beds

The Kemble Beds (1) in the mid and south-eastern portion of the district are mainly oolitic, flaggy, false-bedded limestones in some places of a Great Oolite facies, in others of an incipient Forest Marble facies; (2) in the central portion around Aldsworth, Bibury and Barnsley they are blue and grey flaggy limestones, in places obliquely laminated at high angles, with—especially in the lower portion—lenticles of heavy, tough, green, brown and black clays; while in (3) the south-western portion they are almost entirely limestone of Great Oolite facies (but usually with conspicuous false bedding) with occasional layers of brownish marl packed with oysters (*Ostrea sowerbyi* Morris and Lycett).

Locally, there is clear evidence that previous to the deposition of the Kemble Beds there occurred flexing and some erosion of the Great Oolite White Limestone; and that in the south-eastern part of the district, subsequent to the formation of the Kemble Beds and previous to the deposition of the Bradford Clay, there was local uplift (on the line of the southward continuation of the Moreton anticlinal axis), which, in the vicinity of Southrop has apparently resulted in the absence of the Forest Marble Series and in the Kemble Beds being immediately succeeded by the Cornbrash.

In areas (1) and (2), and especially in (2), it is often difficult or impossible to arrive at a decision as to what rock division one is looking at in a section—whether at Kemble Beds with a Forest Marble facies or at true Forest Marble (Wychwood Beds). Unfortunately the Bradford Clay is not exposed in these areas (1) and (2), so it has to be remembered that Bradford Clay with *Ornithella digona* (J. Sowerby) at Carterton rests on Kemble

Beds of Great Oolite facies and at Witney on Kemble Beds more of a Forest Marble facies, and deductions made accordingly (see also pp. 73, 74).

In the south-western part of the district (3), however, the Kemble Beds are mainly of a Great Oolite facies, and in the vicinities of Kemble (just outside the district to the south-west) and the Royal Agricultural College, Cirencester, are succeeded by Bradford Clay with its characteristic brachiopods.

From the foregoing remarks it will be readily understood why there has been so much discussion as to the allocation of the beds between the White Limestone and Cornbrash—whether to the Great Oolite or to the Forest Marble—and it will be equally readily appreciated why James Buckman,[1] who worked mainly in the south-western portion of the district, claimed all the beds between the White Limestone and Bradford Clay as Great Oolite, and Hull—with his more extensive and detailed knowledge—deemed it best to represent the extent of all the intervening beds by one colour on the Geological Survey Map for which he was responsible. For correlation purposes, however, it is necessary to select one or more distinctive fossils to mark the commencement of what should be regarded as Forest Marble. The brachiopods *Ornithella digona* (J. Sowerby), *Eudesia cardium* (Lamarck), and *Dictyothyris coarctata* (Parkinson) are suitable fossils and characterize the Bradford Clay which is here accepted as the lowest constituent deposit of the Forest Marble Series.

Details : White Limestone and Kemble Beds

A quarter of a mile to the east of the district under consideration, at a point 2 miles south-south-east of Holwell and 7 furlongs south-west of Carterton cross-roads (Sheet 236), a disused quarry in a spinney by the roadside[2] gave the following section :—

Quarry S.W. of Carterton cross-roads

	Ft.	In.
Bradford Clay :		
Clay, buff	3	0
Fossil Bed. Argillaceous limestone, hard in centre, marly above and below ; *Ornithella digona* (J. Sowerby) very abundant : *Dictyothyris coarctata* (Parkinson), *Kallirhynchia obsoleta* (Davidson), *K. sp.*, *Modiola imbricata* J. Sowerby, *Eocallista loweana* (Morris and Lycett)	1	0
Clay, buff to grey with some *Ostrea sowerbyi* Morris and Lycett at base	3	0
Kemble Beds :		
Limestone, grey, coarsely but sparsely oolitic, with a certain amount of shell fragments, becoming finer grained and more compact below ... seen for	5	0

About half a mile south-west by south of Holwell there is a disused Brick and Tile Works. The section in the ' pit ' is now much obscured, but it was

[1] ' On the Oolitic Rocks of Gloucestershire and North Wilts,' *Quart. Journ. Geol. Soc.*, vol. xiv, 1858, p. 113.

[2] Described by W. J. Arkell ' The Upper Great Oolite, Bradford Beds and Forest Marble of South Oxfordshire, and the Succession of Gastropod Faunas in the Great Oolite,' *Quart. Journ. Geol. Soc.*, vol. lxxxvii, pt. 4, 1931, p. 563.

described by Woodward,[1] who was puzzled at first as to whether the beds belonged to the Forest Marble or Great Oolite. On reflection, he came to the conclusion that " they belong mainly to the Marly Beds beneath the White Limestone, as seen at Milton, and elsewhere." In 1930 the rocks displayed at the north-eastern end of the ' pit ' were as follows :—

Holwell Brick and Tile Works

	Ft.	In.
Wychwood Beds (Forest Marble) :		
Flaggy, sandy, typical Forest Marble with clay galls ; *Ostrea sowerbyi* (Morris & Lycett), *Isodonta sp.*, *Kallirhynchia sp.* ... ... up to	4	0
Bradford Clay : clay, buff ... ... about	6	0
Kemble Beds (Great Oolite) :		
Limestones, fairly massive, locally false-bedded, greyish, oolitic (coarsely so in the top portion) ; shell fragments ... ... seen for	6	0

The Bradford Clay fossil-bed fauna is absent, but, after seeing the section near Carterton, there can be no doubt that the position of the *Ornithella digona*-Bed is about the middle of the clay identified with the Bradford Clay. The 5½-ft. bed of clay that was dug for brick- and tile-making occurred—according to Woodward—at the bottom of the pit : as remarked by Dr. Arkell it is probably part of a clay lenticle in the Kemble Beds such as is seen in the Crawley Road Quarry, Witney.[2]

The Kemble Beds are well displayed in Holwelldowns Quarry in a field on the west side of the road a mile to the west of the Holwell ' pit,' where they consist of oolitic, flaggy, and highly false-bedded limestones, as under :—

Holwelldowns Quarry

	Ft.	In.
? Bradford Clay (residual) :		
Heavy, chocolate-coloured clay soil ... ... up to	1	6
Kemble Beds :		
Limestone, locally false-bedded, fissile	2	0
Marl, brownish ; *Epithyris* (crushed. *?E. oxonica* var. *kemblensis* Arkell), *Kallirhynchia sp.*	1	0
Limestone, sandy to the touch, false-bedded and ripple-marked	4	0
Clay, greenish, and films of brown ironstone	0	4
Limestone, more massive but false-bedded seen for	4	0

Similar limestones have been quarried half a mile to the north-north-west, and four-fifths of a mile to the north-north-west, but in the latter quarry the marl is more regularly developed and clayey, and the limestone beds are much more variable in lithic structure—grey, sandy ; brown, sandy ; and grey and yellowish and coarsely oolitic.

The bottom part of the Kemble Beds is to be seen resting on White Limestone in a quarry in the south-western angle made by the cross-roads about half a mile east of Fourmile House on the Burford-Cirencester road or one and one-fifth miles west of Westwell, the section being as follows :—

Cross-roads Quarry, near Westwell

	Ft.	In.
Kemble Beds (of incipient Forest Marble facies) :		
Limestone, flaggy ; oysters (bluish) abundant in the lower portion ... ... seen for	3	0
Marl, yellowish ; fragments of oysters abundant... ...	1	0
White Limestone :		
Dagham Stone. Limestone, hard, white, oolitic; seen for	1	0

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 305.
[2] *Quart. Journ. Geol. Soc.*, vol. lxxxvii pt. 4, 1931, p. 593.

At a point half a mile W.15°N. from Westwell a quarry displays 10 ft. of flaggy Kemble-Bed limestones—containing *Placunopsis socialis* (Morris and Lycett)—with marl partings, overlaid by a heavy, chocolate-coloured clay soil that may be residual Bradford Clay.

In a quarry by the Burford road near Westwell, Hull noticed—apparently in the White Limestone subdivision—a bed of conglomerate : " The fragments may be seen standing on end, or loosely heaped together, as if they had been broken up by a storm, dashed about, and then retained in their places by a rapid formation of new calcareous matter." Hull gave a sketch of what he saw,[1] and Woodward has noticed the section.[2]

White Limestone, with associated marly clays (which throw out the water), is seen at the spring on the west side of Westwell (that supplied the village previous to the installation of a piped service), and abundant rubble of the white rock covers the portion of the field adjacent to the Westwell-Holwell road between Westwell and the bridge that carries the road over the often non-existent Shill Brook.

About half a mile south-east of Little Barrington, on the south side of the main road, there is a quarry traversed by a fault. In the western part of the quarry—as noticed by Woodward[3]—there is typical White Limestone that has been quarried for lime-burning, while in the eastern part Kemble Beds (seen 12 ft.—flaggy limestones with occasional clay lenticles) are overlaid by a red clay (? residual Bradford Clay) up to 1 ft. 6 in. in thickness. The Kemble Beds are still worked for tile-stones.

The following interesting exposure occurs in Rangehill Quarry, three-fifths of a mile south of Windrush :—

Rangehill Quarry

	Ft.	In.
White Limestone :		
Marl, creamy white, and chalk-like stone	0	8
Limestone, hard, white—a poor Dagham Stone	0	10
Marl, grey, barren ... ... about	2	0
Limestone, white, irregular, the top portion containing a multitude of little ' pellets ' of structureless white limestone like those in the rock in the Daglingworth Downs Quarry (p. 69) ... ... seen for	1	6

On the south side of the Oxford road, at about 1 mile south of Sherborne, White Limestone has been extensively quarried—especially in the past—for lime-burning. Details are as follows :—

Quarry South of Sherborne Park

	Ft.	In.
Soil, with in places immediately below and entering the Great Oolite pockets of tough, green and brown clay	—	—
White Limestone :		
Terebratula-Marl.[4] Marl, slightly stony, yellowish but locally white and chalk-like with abundant *Epithyris oxonica* Arkell var. *transversa* Arkell, and *Lima cardiiformis* Morris and Lycett ; *?Cererithyris sp.*, *Kallirhynchia* cf. *concinna* (J. Sowerby) (rare), with, at the base	4	0
Oolite, yellowish-brown (*cf.* bed below Fossil Bed at Sapperton Tunnel, p. 71)	0	6

[1] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 64, fig. 7.
[2] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 302.
[3] *Idem*, p. 301.
[4] About a mile to the south-south-west, in a field on the west side of the road to Aldsworth, is a shallow disused quarry in which this bed is seen as rubbly limestone and marl full of Epithyrids and *Lima cardiiformis* Morris and Lycett, overlying white Dagham Stone.

	Ft.	In.
White limestone—the upper part hard, grey-white but locally pinkish, ' flinty,' with planed top. The lower part is considerably fossiliferous but the fossils occur mostly in the form of casts ; *Nucleolites*, *Montlivaltia*, *Trigonia*	1	0
Limestone, white, coarsely oolitic, passing down at about 2½ ft. through browner and more sparsely oolitic rock into, at 5 ft. from the top	5	0
Limestone, hard, grey-brown, non-oolitic, sandy ; seen for	1	0

The majority of the Terebratulids in the *Terebratula*-Marl are akin to *Epithyris oxonica* var. *transversa* Arkell—the characteristic form of the Lower *Epithyris*-Bed of Oxfordshire ; but it should be noted that even in this section the Marl is locally destitute of fossils. The Marl may also be contemporaneous with the *Terebratula*-Marl of the quarry near Crickley Barrow House (p. 55).

The origin of the pockets of clay at the top of the section is obscure : the deposit is similar to certain of the Kemble Bed clays. In one part of the quarry is to be seen a long irregular root-like ' pipe ' of very similar clay *in* the *Terebratula*-Marl. On Hampnett Glebe, 1 mile west of Northleach Church, there is a ' dead ' clay patch on which practically all crops fail. This patch is environed by rubble of typical White Limestone, and the clay is similar to that seen in the pockets and ' pipe ' at this quarry (see also p. 97).

About 1½ miles to the west, on the north side of the road opposite New Barn, there is a section very similar to the last (see below), but it is noteworthy for the abundant occurrence of a species of *Pseudomelania*.

New Barn Quarry near Northleach

	Ft.	In.
White Limestone :		
Yellowish-brown oolite ' sand '	0	6
Limestone, yellow and grey, oolitic, shelly, somewhat ' flinty ' in the lower part...	1	0
Terebratula-Marl. Marl, clayey, slightly stony ; *Epithyris oxonica* var. *transversa* Arkell (rare), with, at the base	1	6
Oolite, pale brown	0	10
White limestone—the top 8 in., a poor Dagham Stone ; packed with *Pseudomelaniae*	1	10
Limestone, white, more oolitic than the bed above ...	3	6
Limestone, brownish, with yellow angular grains; seen for	1	0

Just to the south of Leach Bridge on the Aldsworth-Bibury road is an important section in a roadside bank and quarry, as under :—

Leach Bridge Section near Aldsworth

	Ft.	In.
Kemble Beds (Forest Marble facies) :		
Marl, grey, passing horizontally from the lower portion upwards into marl-parted false-bedded limestones of variable lithic structure—sandy in some places ; blue-grey, shelly, and of Forest Marble facies in others seen for	6	6
White Limestone :		
Aphanoptyxis bladonensis-Bed. White limestone, very hard, locally ' flinty ' with very abundant *Aphanoptyxis bladonensis* Arkell and *Gervillia waltoni* Lycett ; *Protocardia subtrigona* (Morris and Lycett), *Trigonia* cf. *flecta* Morris and Lycett and *Eocallista loweana* (Morris and Lycett) also common	2	3
Marl, yellow	0	3
Limestone, grey, compact, unfossiliferous...	1	6

Hull[1] gave a section in the Forest Marble and Great Oolite, by the Burford road, at a quarter of a mile south of Aldsworth, which represents that now under consideration, but the present section is a mile along the Bibury road from Aldsworth. Hull discussed the Kemble Beds as Forest Marble and saw a clay lenticle packed with oyster shells. The top bed of the White Limestone was identified with the *Aphanoptyxis bladonensis*-Bed of Oxfordshire by Dr. Arkell,[2] who visited the section in the writer's company.

The Kemble Beds vary considerably in lithic structure in this immediate neighbourhood : the beds that were quarried in the old workings at a slightly higher level in the field to the south of the Leach Bridge section, and the false-bedded, fissile, oolitic, shelly (oyster) limestones displayed (7 ft.) in the Bratch Quarry, half a mile to the south-east, belong to them.

Close to Knoll Barn, 1 mile north of Coln St. Aldwyn, is a quarry displaying horizontally bedded Forest Marble resting upon Kemble Beds obliquely bedded at high angles (Plate VA). The masses of extremely shelly limestone at the top of the north-western portion of the section are similar to the highly shelly limestone seen in the Eastleach Turville Quarry.

Knoll Barn Quarry

	Ft.	In.
Forest Marble :		
Limestone, highly shelly ... ... up to	1	0
Limestone, very fossiliferous (*Astarte* cf. *angulata* Lycett, *Gervillia* cf. *waltoni* Lycett) except in the median portion which is white and locally marly	2	0
Marl, brown ; abundant *Ostrea sowerbyi* Morris and Lycett	1	0
Great Oolite ; Kemble Beds :		
Limestones, very shelly, blue-grey, obliquely bedded, furnishing large thin flags ... ... seen for	6	0

At Lambrough Barn, 1 mile north-north-east of Ablington, near Bibury, the junction of the Kemble Beds with the White Limestone is again clearly displayed :—

Lambrough Quarry, near Ablington

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Clay, heavy, tough, green and brown ... ... up to	2	0
Limestone, bluish-grey, shelly, appearing locally to pass laterally into stone and yellow-green marl full of *Ostrea sowerbyi* Morris and Lycett	2	0
Limestone, bluish-grey, oolitic, shelly, weathers flaggy, locally false-bedded	3	6
Marl, yellowish	0	3
Limestone, bluish-grey	1	2
White Limestone :		
White limestone ; gastropods (*Natica* or *Cerithella*-like gastropods), etc.	2	0

There are many quarries in the vicinity of Crickley Barrow, to the north-east of Coln St. Dennis : the most interesting occurs some 220 yds. north-north-east of the Barrow in the field alongside the Northleach road. Hull[3] gave a sketch of a section through the Forest Marble and Great Oolite at Crickley Barrow, to demonstrate the occurrence of " oblique lamination of

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[1] ' The Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 70, and fig. 8.
[2] *Quart. Journ. Geol. Soc.*, vol. lxxxvii, 1931, pp. 618-19.
[3] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, fig. 10, p. 71.

a very marked kind " in the ' Forest Marble.' The section may have been in this quarry, but no very marked false bedding is now displayed. The beds he termed Forest Marble are the Kemble Beds, exposed as follows :—

Crickley Barrow Quarry

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Limestone, light brown, sandy, shelly ; *Lima cardiiformis* Morris and Lycett, common	0	9
Marl, stony ; upper part whitish : lower part greenish-brown, clayey ; occasional oyster	1	3
Limestone, grey, sandy with carbonized plant fragments, but passes down into a limestone closely resembling typical Forest Marble ; *Chlamys vagans* (J. de C. Sowerby), *Ostrea sowerbyi* Morris and Lycett, *Epithyris oxonica* var. *kemblensis* Arkell ... ... seen for	5	0

At a point one-fifth of a mile south-east by south of the cross-roads at the Barrow, there is a quarry in which the marl bed (2 to 4 in.) of the preceding section is to be seen overlying some 11 ft. of limestones of variable lithic structure—oolitic, obscurely oolitic, sandy, bedded but locally false-bedded. Three-tenths of a mile south-west of the cross-roads a quarry in a field on the east side of the road to Coln St. Dennis displays 9 ft. of limestones comparable with those visible in the last section, and the bed that floors the quarry contains numerous specimens of *Placunopsis socialis* Morris and Lycett (*cf.* section near Westwell, p. 52). The quarries at 1⅛ and 1½ miles north-north-east of the cross-roads at the Barrow and close to the North-leach road are in very similar limestones. White Limestone is seen cropping out in the side of Lousehill just west of the spring in the valley two-fifths of a mile west by south of the cross-roads at Crickley Barrow ; a clay bed in the White Limestone throws out Lousehill Spring ; while Fullers' Earth throws out those lower down the valley below Manor Farm.[1]

Quarry, Crickley Barrow House (near Cottage Farm)

	Ft.	In.
White Limestone :		
Terebratula-Marl. Marl, slightly stony, yellowish but locally white with a median band (6 in.) of shelly, oolitic, false-bedded limestone ; *Epithyris oxonica* var. *transversa* Arkell and var. *alta* Arkell in equal proportion ; *Cererithyris sp.*, *Burmirhynchia injusta* S. Buckman, *Kutchithyris circumdata* S. Buckman, *Rhactorhynchia faecunda* S. Buckman, *Lima cardiiformis* Morris and Lycett, *Chlamys obscura* (J. de C. Sowerby) (=*Pecten annulatus* J. de C. Sowerby)	4	6
Limestone, creamy white to pinkish brown, shelly and oolitic	5	4
Marl and stone, locally brown and clayey ... average	0	2
Limestone—as before.		

The *Terebratula*-Marl would appear to be comparable with the bed so distinguished in other sections in this district (pp. 52, 53, 55, 71) and with the Lower *Epithyris*-Bed of Oxfordshire.

Some 300 yards east-south-east of Cottage Farm is a small quarry interesting as productive of—according to Prof. H. L. Hawkins—" absolutely typical" specimens of *Clypeus mülleri* Wright.[2] This fossil occurs, in this district, in

[1] ' Wells and Springs of Gloucestershire ' (*Mem. Geol. Surv.*), 1930, p. 77.

[2] The writer has collected similar " absolutely typical " examples from White Limestone rubble on a field near the Taynton Quarries, near Burford.

the top portion of the White Limestone, ranging in the railway-cuttings (p. 62) from beds 8*a* to 5 inclusive.

In the area between the Cheltenham-Oxford road and the River Coln, that is, around Aldsworth, and, to a lesser extent, around Yanworth and Compton Abdale, the White Limestone is displayed in many small quarries and exposures and as rubble on fields.

Rubble of typical White Limestone occurs in the vicinity of the cross-roads west of Helen's Ditch ; on the field three-tenths of a mile south-west by south of Northleach Church ; about 150 yds. west-south-west of the Seven Springs, Northleach ; on Hawk Hill, three-tenths of a mile south-east by east of Compton Abdale Church ; and the rock may be seen *in situ* in a quarry three-tenths of a mile south-east by east of Oxpens, Yanworth. White Limestone—as noted by Hull—used to be worked on Puesdown Hill near the 15th milestone from Gloucester on the Oxford road. Hull observed : " The marly beds near the base of the upper zone [of the Great Oolite] may be seen in a small quarry near the ' Seven Springs,' Northleach. Here they yield, beside two or three species of echini, some beautiful specimens of *Terebratula digona* Sowerby, in translucent calcareous spar, and with these a coral, *Anabacia orbulites* [*porpita* Smith], and another species not unfrequent in this neighbourhood."[1] The *Ornithella*-Beds (see p. 62) therefore, appear to be present here : Ornithellids range from beds 14 to 8*a* inclusive in the railway-cuttings.

Near Lodge Park, Eastington, about 2¼ miles E.43°S. of Northleach Church, in a field adjoining the west side of the road to Aldsworth, the following section is exposed :—

Quarry near Lodge Park, Eastington

	Ft.	In.
White Limestone :		
Marl, pale yellow, and small chalk-like stone rubble 0 to	1	6
Limestone—a Dagham Stone at the top (5 in.) ; then more rubbly and mixed with marl (11 in.), and more massive in the lower half	3	3
Limestone on the whole of massive appearance	3	2
Limestone, hard, grey, sandy ... ... seen for	3	4

Fossiliferous White Limestone is seen in quarries at distances of 1½ miles west and south-west by west of Aldsworth :—

Quarry 1½ miles west of Aldsworth

	Ft.	In.
White Limestone :		
Marl, yellowish	2	0
Dagham Stone with planed oyster-covered surface and well drilled by annelids	1	0
Limestone, whitish, rubbly ; *Nerinea bathonica* Rigaux and Sauvage, *Epithyris sp.*, *Lucina bellona* d'Orbigny, *Trigonia sp.* ... ... seen for	2	6

Typical White Limestone is exposed at several places near Bibury, *viz.* opposite Bibury Farm ; at White Hill, and close to the road from Bibury to Coln St. Aldwyn three-fifths of a mile east 5° north of Bibury Church ; while from off the fields in the obtuse angle made by the track to Knoll Barn and the road to Coln St. Aldwyn the writer has picked up pieces of Dagham Stone containing *Nerinea sp.* and numerous corals — *Isastraea limitata* (Lamouroux), *Comoseris vermicularis* (M'Coy), etc. White Limestone, with *Nerineae*, appears in an old quarry east-south-east of the windpump in the valley above Sheepbridge, and at a point two-fifths of a mile north-east by east of Eastleach Martin Church.

[1] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 62.

The Great Oolite of the area between the River Coln and the railway from Cirencester to Chedworth will now be dealt with.

A quarter of a mile west-north-west of Quenington Church, in the angle made by the Ampney and Fairford roads, a shallow quarry is in the process of being filled in and obscuring the following section :—

Quarry at Quenington

	Ft.	In.
Kemble Beds (F.M. facies) :		
Clay, grey, with a limestone layer of typical Forest Marble facies ; *Ostrea sowerbyi* Morris and Lycett ...	4	0
White Limestone :		
Limestone, hard, white, locally ' flinty ' ; *Parallelodon rugosa* (J. Buckman), *Anisocardia sp.* ... seen for	2	6

Just west of Godwin's engineering works is clay—doubtless a continuation of the Kemble Bed clay of the last section—and, on the north side of the road, a deep quarry displaying 24 ft. of bedded (locally false-bedded) oolitic limestones, soft in places and weathering so as to suggest a series of alternating limestones and marls. There are no signs of ' flinty ' White Limestone in the neighbourhood either above or below, nor any distinctive fossils to enable one to determine the precise stratigraphical position of these unexpectedly thick limestones ; but in view of the occurrence of clay on the south side of the road and above the White Limestone in the quarry at Quenington, it would appear that these limestones belong to the White Limestone subdivision.

Higher beds came on about three-quarters of a mile to the west, where, in a quarry outside the southern limit of Coneygar Wood, the Kemble Beds are displayed as follows :—

Coneygar Wood Quarry, near Quenington

	Ft.	In.
Kemble Beds (F.M. facies) :		
Clay, dark green in the upper part, bluish in the lower	4	0
Kemble Beds (Great Oolite facies) :		
Limestone—the upper part grey and locally blue-grey and fissile (yielding tile-stones) ; the lower part a white oolite with occasional plant remains, weathering soft at the bottom ... ... seen for	6	6

The quarry situated 1½ miles south-east by south of Coneygar Wood, on the west side of the road from Quenington to Fairford, is that referred to by H. B. Woodward as " South of Pilham Lodge."[1] The present section is detailed below :—

Quarry S. of Pilham Lodge, near Fairford

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Fairly regular stratum of fissile limestone of incipient Forest Marble facies ... ... up to	1	0
Marl, grey and white, locally limestone and indurated marl from which the writer collected an *Epithyris marmorea* (Oppel), replaced—as a rule—in the lower part by shelly limestone	7	6
Clay, blue-grey, fairly persistent	1	0
Limestones, grey and locally blue-grey, shelly (incipient F.M. facies)—in the northern portion of the quarry fairly regularly bedded, but when traced southward are found to become wedge-bedded and parted by layers of clay and/or marl ... ... up to	12	0

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, pp. 369-70.

Woodward regarded the beds as Forest Marble. F. H. Engleheart also has collected specimens of *Epithyris marmorea* (Oppel) here, and both his and mine are typical of that species. I incline to the opinion that these beds are Kemble Beds and that the true Forest Marble succeeds to the south. What the true Forest Marble is like in this neighbourhood may be gathered from a quarry section about three-quarters of a mile to the south-west, on the south side of the road from Fairford to Sunhill, where it consists of regular, alternating beds of limestone and clay.

Quarry 220 yards south of Sunhill

	Ft.	In.
Kemble Beds (Forest Marble facies) :		
1. Limestone, flaggy	—	—
White Limestone :		
2. Marl and clay, stony, white ; *Ornithella digona* var. *minor* J. Martin,[1] *Ostrea sowerbyi* Morris and Lycett	1	6
3. Limestone, grey, locally blue-grey, on an average 1 ft. 9 in. thick but thickens to 2 ft. 2 in. where it fills in a wash-out and extends down to bed 6. Locally it passes horizontally into white marly rock (Fairford Coral Bed) with clusters of a large oyster belonging apparently to the *Ostrea sowerbyi* group ... ... up to	2	2
Clay, marly, yellow and oolitic, cutting across beds 4 and 5 and extending down to bed 6 ... ... 0 to	0	6
4. White limestone, hard, 'flinty,' sparsely oolitic, bottom portion crumbly and white ; *Nerinea spp.* and occasional bits of lignite	1	4
5. Clay, dark ... ... 0 to	0	3
6. White limestone, hard ; bits of lignite seen for	2	9

It should be noted that the marl with Ornithellids comes above a bed that contains rock similar to that of the Fairford Coral Bed, which is well developed in the next quarry. In the railway-cuttings Ornithellids have not been found above bed 8a (see p. 62) so that it would appear that here certain of the top beds of the White Limestone are absent.

The next quarry (Plate II, A,B,) is a little farther south—three-tenths of a mile south of Sunhill—the following section being exposed :—

Hampton Fields Quarry

	Ft.	In.
Red clayey soil	—	—
Kemble Beds (Forest Marble facies) :		
Clay, heavy, greenish-grey, with films of sandy limestone and a prominent layer of limestone of typical Forest Marble facies (with *Ostrea sowerbyi*) at the base ...	4	0
1. Limestone, flaggy, blue-grey, of incipient Forest Marble facies ; attenuates from west to east ... ... 0 to	2	0
Gravel, thins from west to east ... ... 0 to	1	0
White Limestone :		
3. Limestone of variable lithic structure : the bulk of the bed passes eastward into a rubbly, marly, very fossiliferous rock (the Fairford Coral Bed) with corals, *Lima cardiiformis* Morris and Lycett, oysters, gastropods (*Natica sp.*, *Fibula* cf. *variata* Lycett), etc., but the majority of the gastropods occur below the rock in which corals are abundant (namely in 4 below) ...	2	8
4. Gastropod limestone	1	4
5. Marl, cream-coloured and yellow	0	2
6. 'Roadstone,' white, hard, locally 'flinty' and in places blue-hearted ; bits of lignite ... seen for	3	0

[1] =*Zeilleria martini* Rollier. Identified by Miss Helen M. Muir-Wood.

A.—JURASSIC GRAVEL AT BASE OF KEMBLE BEDS, HAMPTON FIELDS QUARRY, SUNHILL, NEAR FAIRFORD.

B.—SECTION IN HAMPTON FIELDS QUARRY.

In this quarry beds 3 to 6 inclusive pass laterally from east to west into a building stone, showing that what is white limestone in one place may be freestone in another.

About one-fifth of a mile west-north-west of Honeycomb Leaze there are two shallow quarries—one on the south side of the road, the other on the north. The section in that to the south of the road is given herewith :—

Quarry north of Honeycomb Leaze Copse

	Ft.	In.
Locally red clayey soil	—	—
Kemble Beds (Forest Marble facies) :		
Clay, greenish-grey and blackish in the basal portion which is full of oysters	—	—
1. Limestone, blue, flaggy, shelly (blue *Ostrea sowerbyi* Morris and Lycett, *Camptochlamys obscura* (J. de C. Sowerby) =*Pecten annulatus* J. de C. Sowerby), a continuous bed	1	3
In the eastern portion of the quarry from which bed 2 is absent this bed is separated from a marly development of the Coral Bed by :—gravel, loose, locally occurring in 'pipes' ... ... o to	o	6
White Limestone :		
2. Marl and clay, yellow ... ... o to	o	6
3. Limestone, yellowish-grey, oolitic, passing laterally into a white marly rock (the Fairford Coral Bed) with corals, *Lima cardiiformis* Morris and Lycett, *Ostrea sowerbyi* Morris and Lycett, etc.	1	2
4. White Limestone, bottom portion crumbly and white; *Nerinea spp.*	1	4
5. Marl and marly limestone, yellowish	o	4
6. Limestone, locally white and 'flinty,' but, as a rule, yellowish-grey and locally blue-hearted	4	o
Limestone, somewhat marly and shaly, forming floor of the quarry; plant remains	—	—

A consideration of the facts obtainable in the last four quarries (the two near Sunhill and the two near Honeycomb Leaze) makes it clear that shortly after the formation of bed 4 conditions of deposition became unstable ; that the Fairford Coral Bed was formed during this period of instability, and that unstable conditions continued until the time of formation of bed 1. In the quarry on the north side of the road west-north-west of Honeycomb Leaze the rock on the horizon of the gravel of the Hampton Fields Quarry (and the quarry north of Honeycomb Leaze Copse) is seen to have been extensively broken up into angular fragments before the deposition of bed 1.

At one time the Fairford Coral Bed received much attention. R. F. Tomes[1] said that many corals were collected by Miss Slater " whose attention was first directed to them by the appearance of numerous corals scattered over the surface of a ploughed field [about one-third of a mile east of Honeycomb Leaze Farm]. Subsequently a great many unworn and beautiful examples were obtained from excavations made for the purpose of collecting specimens." The Coral Bed was regarded by Lycett as occurring " at the base of the Cornbrash ; [2]" by Brodie as probably connected with the Forest Marble or perhaps with the Cornbrash [3] ; by T. J. Slatter " as the base of the Forest Marble and as probably on the horizon of the Bradford Clay " [4] ; and by H. B. Woodward, who gave a record of a section at Honeycomb Leaze to demonstrate its position, " as belonging to the Great Oolite."[5]

[1] *Quart. Journ. Geol. Soc.*, vol. xxxix, 1883, p. 169.
[2] 'The Cotteswold Hills,' 1857, p. 54.
[3] 'Contributions to the Geology of Gloucestershire . . . ,' *The Geologist*, vol. 1, p. 43.
[4] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 297.
[5] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 297.

The Fairford Corals include :—

Bathycœnia slatteri *Tomes*
Cryptocœnia microphylla *Tomes*
——— tuberosa (*Duncan*)
Isastraea explanulata (*M'Coy*)
——— gibbosa *Duncan*
——— limitata *Lamouroux*
Microsalena excelsa *Edw. & Haime*
Montlivaltia fairfordensis *Tomes*
Stylina solida (*M'Coy*)
Thamnastraea lyelli *Edw. & Haime*
———waltoni *Edw. & Haime*
Thecosmilia slatteri *Tomes*
Anabacia porpita (*Smith*)[1] (= A. orbulites (*Lamouroux*) and A. complanata (*Defrance*)) : one example only.

At Ready Token, 2 miles west of Coneygar Wood, a large quarry in Kemble Beds offers the following sequence :—

Ready Token Quarry, near Bibury

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Limestone, greyish-white, oolitic, weathering horizontally into thick tile-stones	2	0
Clay, dark-green, yellow and locally reddish-brown up to	0	10
Kemble Beds (Great Oolite facies) :		
Limestones, noticeably false-bedded	7	8
Clay, greenish and yellow-brown, with thin layers of creamy white mudstone ... ...2 to 10 in., say	0	6
Limestone with oysters and clay galls	0	6
Limestones, massive-bedded, but locally false-bedded ...	2	9
Limestone, fissile	1	3
Limestone, more massive but locally false-bedded ...	2	6

The bottom 6½ ft. of limestones are very similar to those exposed in the Holwelldowns Quarry and in the quarries west of Westwell ; and the section —as a whole—is reminiscent of that in the Chesterton Lane Quarry, Cirencester, the ' Limestone with oysters and clay galls ' here may represent the Oyster Bed there (p. 66).

About 2 miles west-south-west of Ready Token is the ' Section south-west of Long Furlong, Ampney, near Cirencester ' that was sketched and recorded by Woodward[2] who referred the beds to the Forest Marble. The recent section is given below :—

Quarry near Long Furlong, Ampney Crucis

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Clay, dark-reddish and greenish-brown (faulted in) ...	—	—
Limestone, grey-blue	1	6
Clay, greenish ... ... up to	0	6
Kemble Beds (Great Oolite facies) :		
Limestone, grey-blue, flaggy and slightly false-bedded	2	6
Marl, greenish-yellow and brown, clayey... 0 to	0	6
Limestone, false-bedded, with partings of clay, marl and marly limestone ... ... seen for	5	0

Sections on and near the Great Western Railway between Cirencester and Chedworth.—The sections in the railway-cuttings between Cirencester and Chedworth have been described by Prof. Allen Harker,[3] H. B. Woodward,[4] and, in detail, by the writer.[5] Since the latter described them in 1911 he has

[1] Cox, L. R., ' On British Fossils named by William Smith,' *Ann. and Mag. Nat. Hist.*, ser. 10, vol. vi, p. 287, September, 1930.
[2] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 368 and fig. 105.
[3] ' On the Sections in the Forest Marble and Great Oolite formations exposed by the new railway from Cirencester to Chedworth,' *Proc. Cotteswold Nat. F. C.*, vol. x, pt. 1 for 1889-90, pp. 82-93.
[4] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, pp. 245, 289-291, 366, 367.
[5] ' On the Sections of Forest Marble and Great Oolite on the Railway between Cirencester and Chedworth, Gloucestershire,' *Proc. Geol. Assoc.*, vol. xxii, 1911, pp. 95-115.

re-examined them on several occasions. Little additional information, however, has been obtained so the reader is referred to his description for details. Here, only a vertical section is given (Fig. 2, below) to show what palaeontological horizons have been noted, with such comments on the stratigraphy as seem necessary.

FIG. 2.—*Generalized section of the Great Oolite exposed in the railway-cuttings between Cirencester and Chedworth.*

The Kemble Beds (Great Oolite facies) are seen in the Wiggold Cutting and include, at 1½ ft. above the base, an intermittent bed of marl with Epithyrids reminiscent of the Upper *Epithyris*-Bed of Oxfordshire. The line of demarcation between these beds and the White Limestone is sharply defined : as a rule a layer of rich brown clay intervenes, but where it is absent pebbles of White Limestone are frequently found in the basement bed of the Kemble Beds.

The *Gervillia*-Bed is a highly fossiliferous stratum : its chief fossils are :—*Gervillia waltoni* Lycett, *Clypeus mülleri* Wright, *Nucleolites woodwardi* Wright, *Natica spp.*, *Eocallista loweana* (Morris and Lycett), *Protocardia lingulata* (Lycett) and *P. subtrigona* (Morris and Lycett). Apparently the bed is equivalent to the *fimbriata-waltoni* Beds (the horizon of *Aphanoptyxis bladonensis* Arkell) of Oxfordshire.

Nucleolites woodwardi Wright occurs in some abundance in the lower more rubbly portion of the *Gervillia*-Bed, but in great abundance in the underlying *Nucleolites*-Marl : hence the name of the bed.

The Variable Beds, with locally abundant *Pseudotrapezium caudatum* (Lycett), are best seen in the Folly Barn Cutting south of Chedworth, which (with the Aldgrove and Stony Furlong cuttings) is between Chedworth and Cirencester. Below them here is the *Terebratula*-Marl—a highly fossiliferous deposit containing *Epithyris sp.*, *Stiphrothyris sp. nov.*, *Ornithella digonoides* S. Buckman, *Burmirhynchia hopkinsi* (M'Coy), *Clypeus mülleri* Wright (rare), *Hemicidaris bravenderi* Wright, *Acrosalenia pustulata* Forbes, *Natica spp.*, and *Nerinea eudesi* Morris and Lycett. It should be noted that while *Clypeus mülleri* Wright ranges from 8*a* to 5 (inclusive), it is of commonest occurrence in beds 5 and 6 ; that *Nucleolites woodwardi* Wright is of commonest occurrence in bed 6 ; and that *Burmirhynchia hopkinsi* (M'Coy) ranges from 8*a* to 6 (inclusive).

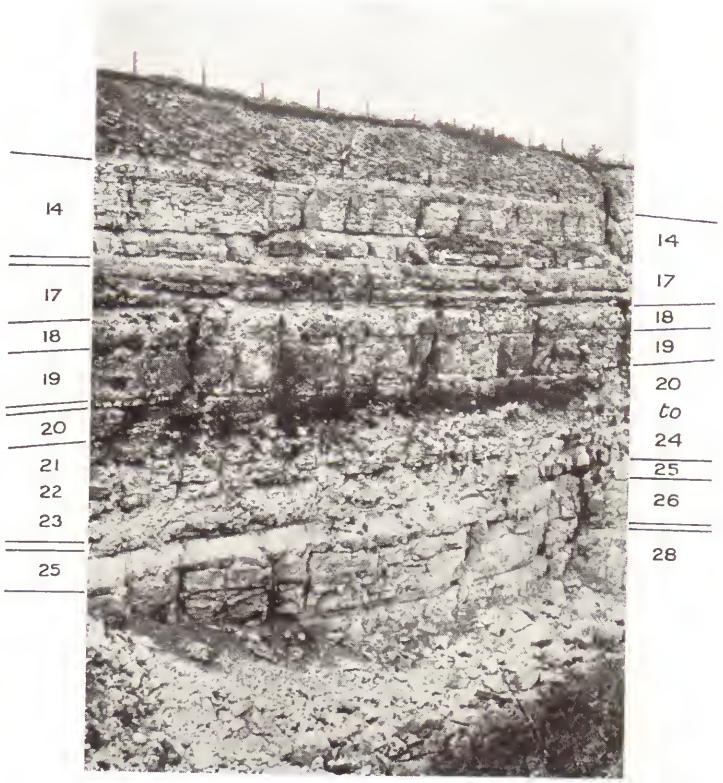
Bed 9 varies considerably in lithic structure and fossil contents. At some places (Stow Road Cutting) it is simply a white limestone ; at others (Folly Barn Cutting) very rich in specimens of *Lima cardiiformis* Morris and Lycett ; and at yet others (Aldgrove Cutting) it is an excellent Dagham or Rockery Stone. Locally this bed 9 contains many corals—*Latimaeandra lotharinga* Michelin, *Microsalena excelsa* Edwards and Haime, etc.

In the Aldgrove Cutting there are three Dagham Stones—9, 11 and 15. Between 9 and 15 is the main horizon for *Solenopora jurassica* Nicholson, often of a beautiful pink tint : hence the name ' beetroot ' applied to it by the quarrymen. In bed 13 here, and in the 1-ft. bed at 1 ft. above the base of 13 in the Stony Furlong Cutting, Dr. W. J. Arkell found *Ptygmatis* (*Bactroptyxis*) *bacillus* (d'Orbigny).

As a result of further investigation it has been found that Ornithellids range from bed 14 to 8*a* (inclusive), so these beds are now grouped as the *Ornithella*-Beds.[1]

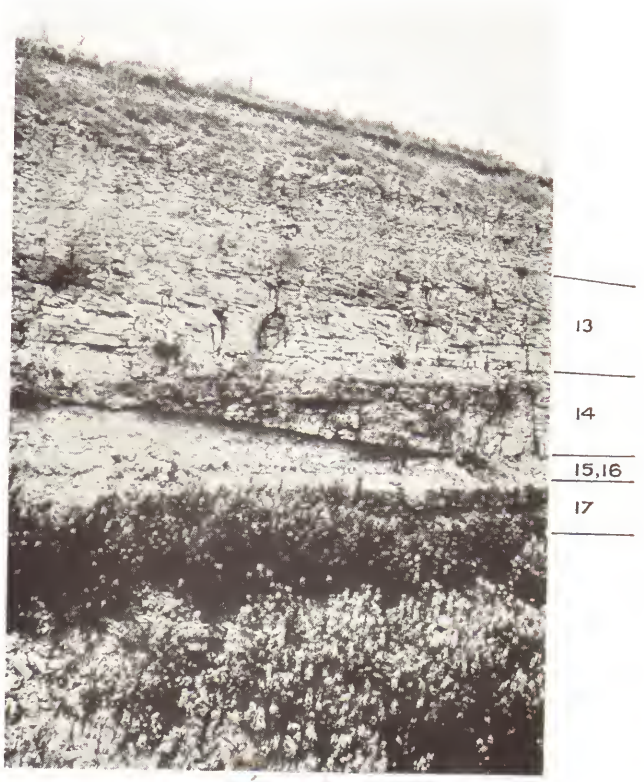
The *Terebratula*-Marl and *Lima cardiiformis*-Bed (9) are well displayed and readily accessible in a quarry near the Aldgrove Cutting—at Old Gore Barn, the barn to the west of the southern end of the cutting and south of the road from Foss Cross to Calmsden. This quarry shows the following section :—

[1] Such a bed as the basal marl bed of these Beds, which locally thickens considerably, probably throws out the spring at the foot of the ancient cross in Calmsden, and not the Fullers' Earth as was at one time suggested as possible by the writer. ' A Handbook to the Geology of Cheltenham . . . ,' 1904, p. 171.



A.—PART OF THE WEST SIDE OF THE STONY FURLONG CUTTING, NEAR CHEDWORTH.

(Figures refer to beds described on p. 61)



B.—PART OF THE WEST SIDE OF THE STONY FURLONG CUTTING, NEAR CHEDWORTH SHOWING THE 'LENTICULAR' MARL BED.

(Figures refer to beds described on p. 61)

Old Gore Barn Quarry, near Calmsden

	Ft.	In.
White Limestone :		
Rubble of white limestone and marl	—	—
Terebratula-Marl. Marl, yellowish, and green clay with associated intermittent limestone beds ; *Stiphrothyris sp. nov.* (abundant), *Ornithella digonoides* S. Buckman, *Burmirhynchia hopkinsi* (M'Coy), a large Rhynchonellid, *Nucleolites woodwardi* Wright, *Nerinea eudesi* Morris and Lycett, etc. ... ... up to	3	0
Dagham Stone or *Lima cardiiformis*-Bed. *Lima cardiiformis* Morris and Lycett, very common, a large Rhynchonellid, *Nerinea eudesi* Morris and Lycett, and corals	0	9
White limestone, bored at top, with very level surface ; some beds massive, others break up into flaggy pieces seen for	8	0

Dr. Arkell informs me that he found a large slab of Dagham Stone, lying loose in the quarry, showing the upper surface planed off perfectly smooth, with all the shells and corals cut through as if by a saw : " So the matrix must have solidified and held the shells before the erosion and deposition on it of the *Ornithella* and *Stiphrothyris* Marls."

The beds below the Dagham (or Rockery) Stone are not readily separable as they have been in the main converted into ' flinty ' white limestone : in the railway-cutting the bulk of the beds between 9 and 14 locally coalesce to form one block of white limestone.

The vertical section from bed 13[1] down to bed 36 is of the Stony Furlong Cutting. The ' lenticular marl '—a local expansion of the basal marl bed of the *Ornithella*-Beds—is the most remarkable feature of the section. *Lopha costata* (J. de C. Sowerby) and an Epithyrid, much smaller than any variety of *E. oxonica* Arkell, are the commonest fossils : other fossils include :—*Ornithella digonoides* S. Buckman, *Burmirhynchia* cf. *hopkinsi* (M'Coy), *Lima cardiiformis* Morris and Lycett, *Thracia curtansata* (Morris and Lycett), *Nucleolites woodwardi* Wright (rare), *Thamnastraea lyelli* Edwards and Haime, *Microsolena excelsa* Edwards and Haime, *Latimaeandra lotharinga* Michelin, and *Corynella punctata* Hinde (Plate III, A,B).

Bed 17 generally consists of two massive-looking beds with shale between and below. To the north—in the direction of the road bridge—the beds on this horizon expand greatly.

Beds 18, 19 and 20 make a very compact group : 21 to 25 (inclusive) a marly group ; and 26 to 28 (inclusive) a compact group again.

The *Lucina*-Beds constitute a notable palaeontological horizon in this cutting and in the neighbourhood ; *Lucina bellona* d'Orbigny is very common and *Pterocardia* [*Cardium*] *pes-bovis* (d'Archiac) is a very distinctive fossil.

The hard, ' flinty,' non-oolitic limestone at the base of bed 23, in one place —towards the bridge—passes into a thick bed of very hard, textureless, compact, pinkish-brown limestone ; practically a china-stone.

It is not easy to identify the equivalent of the Marly Beds of the Hampen Cutting (between Andoversford and Notgrove)[2], in the Stony Furlong Cutting. In the Hampen Cutting a 2-ft. '*Ostrea*-Bed '—a " bluish-grey, shaly marl, [with] *Ostrea sowerbyi* Morris and Lycett large and abundant " is a prominent constituent of the beds at 16 ft. 3 in. from their top and at 10 ft. above their base. Here bed 33 is a similar distinctive bed. It would appear to be contemporaneous with the Hampen bed, but the upper and lower limits of the Marly Beds here (at Stony Furlong) can only be suggested. Unfortunately, lower beds are but imperfectly exposed.

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[1] Concerning a crustacean chela obtained from this bed Mr. Henry Woods, F.R.S., wrote (16 . 8 . 29) : " I think it belongs to the group Paguridae. The genus is probably *Orhomalus*."

[2] ' The Country around Moreton in Marsh ' (*Mem. Geol. Surv.*), 1929, p. 105.

The area between the Cirencester-Chedworth railway and the River Churn will now be considered.

Two miles north-east by north of Cirencester, where the road to Wiggold leaves the Fosse Way, a quarry is made in Kemble Beds which may be described as follows :—

Wiggold Copse Quarry, near Cirencester

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Limestone, weathering somewhat flaggy	1	6
Marl, yellow	0	3
Limestone, fissile, mixed with some marl	1	6
Marl, clayey, greenish-yellow ; *Ostrea sowerbyi* Morris and Lycett	0	3
Kemble Beds (Great Oolite facies) :		
Limestone, false-bedded	3	6
Clay, brown	0	2
Limestone, white, shelly, oolitic, comparatively massive-bedded, locally false-bedded, and locally weathers soft and chalk-like at the top ... ... seen for	6	0

There is a similar section a quarter of a mile east-south-east of Baunton. North-east of Baunton, close to the White Way, is a large quarry (of which a section is given below) displaying beds concerning which Woodward observed[1]: " These beds, mapped by the Geological Survey as Forest Marble, belong to the Upper Division of the Great Oolite (Kemble Beds)." At a lower level than the quarry, on the hillside to the west, rubble of typical White Limestone is to be seen.

White Way Quarry, near Baunton

	Ft.	In.
Kemble Beds (Great Oolite facies) :		
Limestone, flaggy ... ... seen for	1	6
Limestone, oolitic, fairly massive-bedded but the individual strata are false-bedded ... ... seen for	12	0

The section in Hare Bushes Quarry, about a mile north-east of Cirencester, by the side of the Bibury road, may next be described as it also shows Kemble Beds.

Hare Bushes Quarry, near Cirencester

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Limestone, grey, marly, bedded but rubbly	2	6
Marl and clay, greenish-grey, oolitic	0	4
Limestone, flaggy, brownish but locally blue-grey ; lignite, oysters	1	0
Marl, oolitic, abundant *Ostrea sowerbyi* Morris and Lycett	0	5
Limestone, oolitic, shelly, as a rule false-bedded 2 to	3	0
White Limestone :		
Limestone of variable lithic structure, but locally very hard and ' flinty ' ; *Pseudomelania sp.*	1	1
Limestone, chalk-like	1	6
Marl—soft decalcified limestone	0	5
Limestone, grey-white, fairly massive ... seen for	2	0

Woodward described another part of this section[2] : he allocated the top two beds to the "Forest Marble (passage-beds) " ; the next three to the Kemble Beds ; and drew the line between the Kemble Beds and White Limestone as in

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 288.
[2] *Ibid*, p. 284.

the above record. He said : " The false-bedded oolite [the bottom layer of the Kemble Beds rests on a very uneven surface of the compact white limestones, which appear in greater thickness at the southern end of the quarry. The appearances point to some contemporaneous erosion of the strata."

Prof. James Buckman, who described the section in 1858,[1] and did not regard any of the beds as true Forest Marble, found in a bed of ' white freestone ' (probably belonging to the White Limestone) here the reptilian eggs *Oolithes bathonicae* J. Buckman, which he considered to have belonged to *Teleosaurus*.[2] Typical Forest Marble[3] succeeds to the east and is displayed in a small quarry in the grounds of the house called ' Grey Walls,' where it contains abundant Rhynchonellids.

Three-quarters of a mile north-north-east of Baunton, in the angle made by the roads west of the Sisters, the junction of the Kemble Beds and White Limestone is well displayed in a quarry, as under :—

The Sisters Quarry, Baunton

	Ft.	In.
Kemble Beds (Great Oolite facies) :		
Limestone rubble and greenish-yellow marl	2	0
Terebratula-Marl. Marl with abundant *Epithyris oxonica* var. *kemblensis* Arkell	0	4
Limestone, flaggy in the upper portion, massive in the lower	9	0
White Limestone :		
Nerinea eudesi-Bed. Limestone, hard, grey, oolitic, packed with fossils difficult to extract ; *Nerinea eudesi* Morris and Lycett, *Solenopora jurassica* Nicholson seen for	1	0

The *Terebratula*-Marl occupies the stratigraphical position of the Upper *Epithyris*-Bed of Oxfordshire, and the *Nerinea*-containing White Limestone bed was identified with the *Nerinea eudesi*-Bed of that county by Dr. W. J. Arkell.[4]

The *Terebratula*-Marl is to be seen again in a quarry 1¾ miles to the north-east by north.

Quarry east of Calmsden Gorse

	Ft.	In.
Kemble Beds (Great Oolite facies) :		
Limestone, locally false-bedded, the whole weathering flaggy	5	0
Limestone, regular bed	1	0
Terebratula-Marl. Marl, locally stony with abundant *Epithyris oxonica* var. *kemblensis* Arkell (the majority) and some var. *transversa* Arkell...	0	4
Limestone, markedly false-bedded. The lowest beds are somewhat sandy, brownish, irregular, with obscure plant remains, and have adherent films of greenish marl ... ... seen for	4	0

Northward the White Limestone rises to the surface and floors a considerable tract of country.

An interesting development occurs in a quarry at Calmsden[5] where certain beds (probably on the horizon of beds 10 to 13 of the Aldgrove Cutting, p. 63) are a mosaic of white argillaceous limestone and calcite. Dr. J. G. A. Skerl reports on a section (Geol. Surv. Coll. E.14748) : " The slide is of a pseudo-oolitic limestone, consisting of more or less rounded lumps of a fine-grained

[1] ' On the Oolitic Rocks of Gloucestershire and North Wilts,' *Quart. Journ. Geol. Soc.*, vol. xiv, 1858, p. 117.

[2] *Quart. Journ. Geol. Soc.*, vol. xvi, 1860, p. 107.

[3] A trench in the Fairford road a little east of where it parts company with the road to Barnsley revealed, at 5 ft. down, typical Forest Marble.

[4] *Quart. Journ. Geol. Soc.*, vol. lxxxvii, 1931, p. 606.

[5] Recorded in L. Richardson, ' A Handbook to the Geology of Cheltenham,' 1904, p. 172.

argillaceous non-oolitic limestone embedded in a mosaic of calcite. The pieces of limestone vary in size from 0.2 mm. average diameter to 4.0 mm. average diameter, and the smaller grains are invariably rounded to a greater extent than the larger grains. There is a slight development of green chamositic material around some of the grains, but it never encircles the whole grain. There is no development of another zone of calcite around each grain such as occurs with the true oolitic structures. The calcite in which the pseudo-oolites are embedded occurs in grains up to 0.5 mm. in cross section, and is clear and free from argillaceous matter."

The *Lucina*-Beds, considerably fossiliferous except in the first quarry mentioned, are exposed in quarries at the following sites :—the cross-roads a quarter of a mile west by north of the railway station, Chedworth ; three-tenths of a mile north-east of Greenmeadow ;[1] the corner of the former Nordown Aerodrome ground opposite Rendcomb Buildings ; and (three-quarters of a mile south of the preceding) east of North Cerney.

Section in Quarry east of North Cerney

	Ft.	In.
White Limestone :		
17. Limestone, greyish-white, slightly oolitic, flaggy seen for	2	0
Marl, pale yellow, oolitic, locally brown, and clay at the base	0	8
18. White limestone with planed surface with adherent oysters and bored in places ; *Lucina bellona* d'Orbigny	2	9
19. White limestone, loosely rubbly in the upper portion (which is full of *Lucinae*) passing down into a locally more oolitic limestone	5	0
20. Limestone, very hard, slightly ' flinty,' brownish ; *Nucleolites woodwardi* Wright ... seen for	1	0

The rock was quarried for lime-burning.

The area to the west of the River Churn will now be dealt with, commencing with sections at and near Cirencester.

Chesterton Lane Quarry, Cirencester

	Ft.	In.
? Forest Marble :		
Clay with layers of limestone of Forest Marble facies (inaccessible)	—	—
Kemble Beds (Great Oolite facies) :		
Limestone, false- and flaggy-bedded. The top portion is hard and weathered into small flaggy pieces (*cf.* Kemble Beds at Sunhill and Honeycomb Leaze)	6	0
Limestone, marly, somewhat rubbly, ironstained surface. Locally breaks down into marl and is then part and parcel of the bed below (9 to 12 in.)	1	0
Clay, dark, and brownish oolitic marl (lower part) ; *Ostrea sowerbyi* Morris and Lycett abundant in the lower part	1	8
Limestones, oolitic, locally false-bedded, shelly (oysters), with layers of brownish ' shale ' in places	7	0
Oyster Marl. Marl, brownish ; crowded with *Ostrea sowerbyi* Morris and Lycett (mostly large) ; *Chlamys dewalquei* (Oppel) ... ... 6 to 12 in., say	0	6
Limestones, oolitic and false-bedded, more massive-bedded in the lower portion ... ... seen for	17	0

H. B. Woodward remarked that " Great Oolite has been quarried in several places bordering the Great Western (branch) railway south of Cirencester

[1] This is the quarry ' North-east of Rendcomb, and north of Hollybush ' of H. B. Woodward, ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 289.

station. The junction-beds with the Forest Marble are shown in some of the openings . . ." [1] He gave a record of the rocks he saw in one of the quarries and therefrom it is clear that had he been dealing with the Chesterton Lane section he would have called the top bed Forest Marble, the next three Passage Beds, and the lowest three Great Oolite. The clay at the top is inaccessible so could not be searched for fossils, but it is on or a very little below the Bradford Clay horizon (see p. 72). In this quarry the Kemble Beds are thick: 33 ft. 2 in. of them are seen without any indication of typical White Limestone. In the 1924 borehole at Lewis Lane, Great Oolite was entered at 131 ft. 9 in. from the surface and the first typical White Limestone bed was encountered at 187 ft. 7 in. down. This gives a thickness of 55 ft. 10 in. for Kemble Beds.

Kemble Beds are also seen in a small quarry between the Limekiln Quarry and Field Barn to the south-west of the Royal Agricultural College; in a small quarry alongside the field-track from Field Barn to Coates; beneath Forest Marble clay in the cutting on the Stroud road north of the college; and in Cirencester Park, in quarries situated (1) nearly 1 mile west by north of Cirencester Church, (2) south of Ewepens, and (3) three-tenths of a mile north-east by east of Ivy Lodge.

Section in Quarry near Ivy Lodge

	Ft.	In.
Kemble Beds:		
Limestones, oolitic, in four main beds usually false-bedded and brownish, but locally the top portion of each bed breaks down into a soft whitish oolite; weathers 'tiley' ... ... seen for	12	0

The next quarry to be noticed was described by H. B. Woodward.[2] It lies east of Stratton and the present section is as follows:—

Cheltenham Road Quarry, Stratton

	Ft.	In.
Kemble Beds:		
Marl and rubble, yellow, crowded with *Ostrea sowerbyi* Morris and Lycett	2	0
Limestone, marly; crowded with *O. sowerbyi*; *Limea duplicata* (J. de C. Sowerby) ... ... up to	1	0
Marl, as above, and some limestone crowded with *O. sowerbyi*	1	0
Limestone, false-bedded. Shelly—certain layers (*cf.* Ready Token) contain oysters prominently	9	6
Marl, brownish; oysters ... 0 4 Limestones marly; oysters 0 to 1 6 Marl, brownish, passing from a barren marl into marl crowded with oysters 4 in. to 0 9 } Pass eastwards into a brownish marl crowded with oysters ...	2	0
White Limestone:		
Limestone, oolitic, false-bedded	1	3
Marl, yellow and brown, and dark clay	0	6
Oolite, weathering to a chalk-like rubble	2	0
Marl	0	8
Limestone, oolitic (0 to 6 in.)	0	6
Dagham Stone:		
Typical Dagham Stone passing down into	1	4
Oolite, rather soft and soon shivering with the frost seen for	2	0

[1] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 283.
[2] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, pp. 285, 286.

In the neighbourhood of Stratton Church the rocks are much faulted ; the quarry alongside the Ermin Street opposite the lane to the church displays White Limestone with a Dagham Stone, while on the other (west) side of the road are fissile Kemble Beds.

Owing to a fault Kemble Beds are seen well to the north, the following section being exposed between the Ermin Street and Cotswold Farm, 4 miles north-north-west of Stratton.

Quarry near Cotswold Farm, Duntisbourne Abbots

	Ft.	In.
Kemble Beds (incipient F.M. facies) :		
Limestone, grey- to blue-hearted, associated with some marl, the whole crowded with *Ostrea sowerbyi* Morris and Lycett; *Lima cardiiformis* Morris and Lycett, common ... ... seen for	2	0
Clay, black, brown, greenish-brown and reddish with a 1½-in. layer of ironstone at the base ... ... 0 to	2	0
Kemble Beds (Great Oolite facies) :		
Limestone, grey, rarely oolitic ... ... seen for	11	0

The junction of the Kemble Beds and White Limestone is visible in a large quarry at Daglingworth on the west side of the Ermin Street near the 15th milestone from Gloucester, where the section reads as follows :—

Quarry east of Daglingworth

	Ft.	In.
Kemble Beds (Great Oolite facies) :		
Limestone, greyish, sparsely oolitic, shelly, flaggy and locally false-bedded ... ... up to	3	0
Limestone, rubbly, somewhat marly, oolitic ; abundant *Ostrea sowerbyi* Morris and Lycett ; *Ceratomya excentrica* (Agassiz), *Homomya vezelayi* d'Archiac, *Lima cardiiformis* Morris and Lycett, *Lucina bellona* d'Orbigny, *Modiola imbricata* J. Sowerby, *Pholadomya sp.*, *Epithyris sp.*	2	6
White Limestone :		
Marl, yellowish, with pebbles ; *Ornithella digona* var. *emarginata* J. Martin[1]	0	2
Dagham Stone. Limestone, hard, white, ' flinty ' with a planed surface and adherent oysters ; ? *Nerineae*[2]. Passing down into	2	0
Limestone, oolitic, chalk-like ; *Lucina bellona* d'Orbigny (From a bed about 1 ft. from the top Woodward recorded *Nautilus*, *Purpuroidea glabra* Morris and Lycett, *Pecten*, etc.)[3] ... ... seen for	4	0

On the east side of the Ermin Street a little beyond the 14th milestone from Gloucester the White Limestone is quarried for lime-burning. It is remarkably pure—96.88 per cent carbonate of lime (p. 108). The quarry is on what were, before their enclosure, Daglingworth or Dagham Downs. On these downs one of the limestone beds with peculiar tubiform perforations occurs at the surface, and in former days many pieces were taken away for rustic work or rockeries : hence the name ' Dagham Stone.'

[1] = *Zeilleria marcoui* Rollier. Identified by Miss Helen M. Muir-Wood.

[2] According to Dr. W. J. Arkell these gastropods show no sign of internal structure, since they are replaced by a sort of soft ochre. Externally they resemble *Nerinea*, but are unlike any species yet figured from the Great Oolite.

[3] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 286.

A.—DAGHAM STONE IN STRUCTURE OF PUBLIC CONDUIT, NORTH CERNEY.

B.—GREAT OOLITE WHITE LIMESTONE, DAGLINGWORTH DOWNS QUARRY, CIRENCESTER.

Section in Daglingworth Downs Quarry

	Ft.	In.
White Limestone :		
Dagham Stone. Limestone, white, oolitic, much broken up by the weather, the top portion of the rock for a depth of 14 in. having tubiform cavities. In some parts of the rock are many little 'pellets,' regular and irregular, of pure white limestone ; *Lucina bellona* d'Orbigny (rare), *Solenopora jurassica* Nicholson (large mass)	3	2
Limestone, hard, white, oolitic, in places approaching the Calmsden type of rock (p. 65) ; very level top ; *Nucleolites sp.*	6	6
Dagham Stone. Limestone, white, with remarkably level oyster-covered and pitted surface that forms the floor of the quarry	—	—

In places in the Aldgrove Cutting (p. 63) and elsewhere the beds between 9 and 14 coalesce to form one block of White Limestone and contain *Solenopora*. The Dagham Stones of this section may be the equivalents of beds 9 and 15 in the Aldgrove Cutting. If this is the case, on top of the lower Dagham Stone is the horizon at which Ornithellids are so abundant in the Aldgrove Cutting, and on top of the upper Dagham Stone that at which they occur in Old Gore Barn Quarry (p. 63).

Farther north the lower mass of hard White Limestone comes to the surface and floors considerable tracts. This mass includes beds on the horizon of beds 18 and 19—a Dagham Stone and *Lucina*-Beds—of the Stony Furlong Cutting.

White Limestone is being quarried for road-metal a quarter of a mile north of Woodmancote, in the ground known as Ten Acres, the section being as under :—

Ten Acres Quarry, Woodmancote

	Ft.	In.
White Limestone :		
Limestone	—	—
Marl ; *Lucina bellona* d'Orbigny, *Natica sp.*	0	9
White limestone, rubbly in the upper portion which is full of *Lucinae* and *Nerineae*	2	4
White limestone, 'flinty' in places	1	4
White limestone, massive, hard oolite in places	3	8
Limestone ; chalk-like oolite	1	7
Limestone, very hard, 'flinty,' brownish ; clusters of *Nucleolites woodwardi* Wright	2	0

White Limestone is to be seen south of Beechpike on the Ermin Street, north-east of Winstone ; while from rock exposed by the road side about half way between Beechpike and Winstone a specimen of *Pterocardia pes-bovis* (d'Archiac) was obtained. This fossil has also been collected from the *Lucina*-Beds (19) of the Stony Furlong Cutting (p. 63).

Near the north-western entrance to Overley Wood (1⅝ miles west of Duntisbourne Rouse) is a small quarry showing the following section :—

Quarry near Lodge, Overley Wood

	Ft.	In.
White Limestone :		
Limestone rubble (including Dagham Stone) and marl	—	—
Dagham Stone, planed top...	1	2
Limestone, oolitic, with harder and more calcareous portions	1	4
Limestone, oolitic ; *Nucleolites* cf. *woodwardi* Wright ...	3	6
Limestone, yellowish, oolitic ... ... seen for	3	6

White Limestone is also exposed in a number of small openings in Overley Wood, and is well displayed one mile south-west by south of Daglingworth in ' Botany Bay ' thus :—

Botany Bay Quarry, Cirencester Park

	Ft.	In.
White Limestone :		
Dagham Stone	2	0
Marl, yellow	0	10
Dagham Stone. Limestone, hard, white, locally pinkish ; *Nerinea sp.*, passing down into	1	0
Limestone, white, locally hard and ' flinty '	1	6
Limestone, white ; *Lucina bellona* d'Orbigny	1	3
Limestone, oolitic, with level surface : floors the quarry	—	—

To the south-south-east, on the south side of the Stroud road, is an old quarry in White Limestone, above which—on the field—is rubble of Dagham Stone. Slightly lower beds are displayed in a quarry a little to the west near Beechcopse Lodge, as follows :—

Beechcopse Lodge Quarry, Cirencester Park

	Ft.	In.
White Limestone :		
Limestone, yellowish ; broken up and open-jointed, say	6	0
Marl, yellow ; abundant *Nucleolites woodwardi* Wright	0	3
Limestone, massive, with calcareous ' pellets ' at 10 in. above base	3	0
Limestone, oolitic, well bedded	6	6
Limestone, massive bed	2	3
Limestone, thinner bedded... ... ... seen for	3	6

A quarter of a mile west of the 11th milestone from Stroud, on the Stroud road, is Dean's Quarry which shows Kemble Beds on White Limestone, as set out below :—

Dean's Quarry, near Coates

	Ft.	In.
Kemble Beds (Forest Marble facies) :		
Limestone, rubbly, marly, sparsely oolitic ; abundant fragments of *Ostrea sowerbyi* Morris and Lycett, *Chlamys vagans* (J. de C. Sowerby)	—	—
Clay, pale greenish-yellow ; abundant *O. sowerbyi* ...	0	8
White Limestone :		
Limestone, hard, white, planed top	2	8
Marl, yellow, with white rubble ; ? small *Cererithyris*, *Nucleolites* cf. *woodwardi* Wright ... ... up to	1	6
(Locally this deposit passes into rubbly limestone and marl : just west of the limekiln it is 1½ ft. thick and of very gravelly appearance)		
Dagham Stone. Top planed, with adherent oysters ...	2	4
Limestone, yellowish-white, oolitic, in thin but irregularly-surfaced beds ; top bed slightly bored, with planed surface ... ... seen for	6	0

H. B. Woodward[1] referred the beds in this quarry to the Upper Division of the Great Oolite but said that they were lower than those—which " probably belong to the upper division (Kemble Beds) of the Great Oolite "—seen in quarries north-west of Queen Anne's Monument in Cirencester Park. The

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 281.

lowest limestone (at Dean's Quarry) Woodward described as "white oolite and coral-limestones, false-bedded." "The late Joshua Brown of Cirencester, collected many Corals from this quarry, including *Convexastræa Waltoni*, *Isastræa gibbosa*, *I. limitata*, *Thamnastræa Lyelli*, &c. Mr. Tomes compares the Coral-bed with that on Farley Down near Bath [1]" [2]

Section in approach cutting to Sapperton Tunnel from the south-east (West of Hailey Wood and about 4 miles west of Cirencester)

	Ft.	In.
Limestones with an impersistent layer of marl	5	0
Marl and stone, yellowish	0	4
Limestone, locally the top portion is a Dagham Stone ...	1	8
Limestones, oolitic, yellowish-white, in thin but irregularly-surfaced beds, scaling vertically on weathering; top bed slightly bored, with planed surface	9	6
Limestones—a massive bed in the southern portion of the cutting (E. side), where the lower 1¾ ft. is brecciated; but this lower portion passes into a conspicuous brownish soft oolite with plant remains to the north near the entrance to the tunnel	2	10
Limestone with large ooliths similar to those in the Clypeus Grit	1	2
Limestone, hard, with lithographic limestone 'pellets'	1	6
Limestones, oolitic, well bedded, the top stratum weathering 'boulder-like'	11	6
Fossil Bed. Limestone, white, shelly; locally rubbly and associated with a considerable quantity of blue-grey marl in which *Ostrea sowerbyi* Morris and Lycett is abundant: *Epithyris oxonica* var. *transversa* Arkell, *Burmirhynchia sp.*, and *Lima cardiiformis* Morris and Lycett the most noteworthy fossils. *Modiola imbricata* J. Sowerby, *Pseudotrapezium caudatum* (Lycett), *Homomya vezelayi* d'Archiac, *Lima impressa* Morris and Lycett, *Lucina bellona* d'Orbigny, *Nucleolites woodwardi* Wright	2	6
Oolite, yellowish-brown, somewhat soft ... seen for	2	6

The rocks between the lowest bed visible in the cutting and the Inferior Oolite, which were pierced by the tunnel, are—according to the engineer, R. P. Brereton[3]—as follows:—

	Ft.	In.
White Limestone Bed	10	0
Lower Beds of Great Oolite	40	0
Fullers' Earth	80 to 90	0
Inferior Oolite (seen at northern end of Great Tunnel)	—	—

The top beds are similar to those seen in Dean's Quarry, which Woodward said were *lower* than the Kemble Beds. The rocks in this cutting, however, he regarded as Kemble Beds.[4]

The Fossil Bed would appear to be on the horizon of the Lower *Epithyris*-Bed of Oxfordshire and of the *Terebratula*-Marl of the quarry south of Sherborne Park (p. 52), of the quarry near Crickley Barrow House (p. 55), and of Limekiln Quarry near the Royal Agricultural College. The section in the last quarry was described by Woodward[5]: the *Terebratula*-Marl there consists of

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[1] *Quart. Journ. Geol. Soc.*, xli, 1885, p.172.
[2] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 282.
[3] Published by J. H. Taunton, *Proc. Cotteswold Nat. F. C.*, vol. v, p. 255.
[4] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*) vol. iv, 1894, p. 277.
[5] *Ibid.*, p. 282.

white, chalky rubble and marl up to 8½ ft. in thickness, packed with fossils —especially *Lima cardiiformis* Morris and Lycett, *Epithyris sp.*, a Rhynchonellid (crushed) corals (*Isastraea*, etc.) ; in the lower portion of the marl. Locally the lower part of the Marl is replaced from the base upwards (to 4½ ft.) by false-bedded oolite.

There is a fine section in the railway-cutting in Hailey Wood (to the west of Coates), but, unfortunately, the top beds are inaccessible. The section has been described by Woodward,[1] and, although there are differences in detail, it is clear that in general the beds are comparable with those displayed in the approach cutting to the Sapperton Tunnel. The beds are evidently brought up by an anticline and faulted at both ends, although the southern fault is not visible. Woodward grouped all the beds as Kemble Beds and added the following remark : " South-east of the railway-bridge there is a fault that brings on higher fissile beds of gritty limestone and shales, that belong to the Forest Marble." It would appear, however, that all the beds in this cutting belong to the White Limestone, and those faulted down to the Kemble Beds. The lowest bed visible, which is not noticed by Woodward, is a massive creamy-white limestone with planed and iron-stained surface and Dagham Stone perforations in the top portion. *Nerinea sp.*, *Nucleolites woodwardi* Wright, and *Lucina bellona* d'Orbigny, occur in the rock, which is 2½ ft. thick. This bed may be the equivalent of the Fossil Bed in the approach cutting to the Sapperton Tunnel.

Forest Marble

In the Cirencester district the Forest Marble floors nothing like so large an area as was formerly supposed, because much of what was once regarded as Forest Marble has been found to be Kemble Beds—Great Oolite.

At many localities in the central portion of the district it is very difficult to determine to which formation the rocks belong—whether to the Forest Marble or to Kemble Beds presenting a Forest Marble facies, and it is possible that later on rocks in certain quarries may have to be transferred from Forest Marble to Kemble Beds or *vice versa*. The reason for this uncertainty is that locally the lithic structure of the two formations is very similar, and—so far as is known at present—the fossil forms are similar. It may be remarked, however, that whereas in the Forest Marble facies of the Kemble Beds the limestones are strongly false bedded or obliquely bedded at steep angles and sporadically developed, and the clay deposits are heavy and tough, of black, green and brown tints—like Upper Estuarine Clays—and occur frequently in lenticles, the Forest Marble limestones occur in more regular beds —thick and thin—and the clay deposits are more shaly and of a more uniform blue-grey tint.

In the 1924 borehole at Lewis Lane, Cirencester (see p. 75), 66¾ ft. of rock—of which over two-thirds is marl or clay—was proved between the Cornbrash and Kemble Beds of Great Oolite facies. Scarcely half a mile to the south specimens of *Ornithella digona* have been found in clay resting on Great Oolite, so it is clear that the bottom portion of the Forest Marble contains a

[1] *Idem*, pp. 276, 277.

A.—KNOLL BARN QUARRY, NEAR COLN ST. ALDWYN.

B.—EASTLEACH TURVILLE QUARRY: FOREST MARBLE RESTING ON CHANNELLED SURFACE OF KEMBLE BEDS.

representative of the Bradford Clay. (This means that there are some 66¾ ft. of Bradford Clay and post-Bradford Clay deposits, or true Forest Marble, beneath Cirencester.) Ample evidence for Bradford Clay (resting on Kemble Beds) has been obtained at and near the Royal Agricultural College (see p. 76).

The Forest Marble is a series that varies greatly in lithic structure: clay, sand, and limestone replace one another within very short distances. The nature of the beds proved in the borehole at Lewis Lane supports the field evidence that the formation consists mainly of clay over a considerable area in the vicinity of Cirencester.

In proceeding from the Coln valley between Hatherop and Fairford eastwards, in the direction of the southward prolongation of the Moreton anticlinal axis in the neighbourhood of Southrop, the Forest Marble attenuates: apparently the higher beds overlap the lower until from the section south of Southrop the whole is apparently absent—Cornbrash rests upon what appears to be Kemble Bebs (p. 78). In the Eastleach Turville Quarry highly shelly Forest Marble limestones rest locally on deeply channelled Kemble Beds (see below).

Details

At Carterton, north of Black Bourton (Sheet 236), traces of Forest Marble limestone, and Bradford Clay resting on Kemble Beds, are displayed in an old quarry; at the quarry three-tenths of a mile south-west of Southrop Church—4½ miles west-south-west of the Carterton section—the Cornbrash rests directly upon what appear to be Kemble Beds (see p. 78). It is interesting to note that this apparent absence of Forest Marble is on the line of the Moreton anticlinal axis, if produced southward.

On the north side of the road a little to the west of Eastleach Turville (nearly half a mile west of the church), there is a most interesting section in a large, old quarry (Plate V B), as under:—

Eastleach Turville Quarry

	Ft.	In.
Forest Marble; Wychwood Beds:		
Clay, blue-grey weathering brown, with occasional films of limestone in the lower portion... ... seen for	5	0
Limestones, *highly* shelly, flaggy but horizontally bedded; few recognizable shells but *Ostrea sowerbyi* Morris and Lycett occurs ... ... up to	5	6
(*These rest locally on a noticeably channelled surface of the beds below.*)		
Great Oolite; Kemble Beds:		
Limestones, compact, grey, slightly oolitic, obliquely bedded at high angles, locally ripple-marked, with occasional seams of sandy marl ... ... seen for	14	0

Traces of Forest Marble clay overlying Forest Marble limestone with *Ostrea sowerbyi* Morris and Lycett, *Camptonectes laminatus* (J. Sowerby), *Chlamys vagans* (J. de C. Sowerby), etc., are visible in a small quarry towards the top of the bank east of the road at Locombe Hill—two-fifths of a mile north-east by east of Eastleach Martin Church.

The following section is exposed about 1 mile north-west of Eastleach Turville Quarry, in the western corner of the field made by the Akeman Street and Coln Lane Ground:—

Coln Lane Quarry, Eastleach Turville

	Ft.	In.
Forest Marble ; Wychwood Beds :		
Clay—locally filling in fissures	—	—
Limestone, in places shelly, flaggy but horizontally bedded	3	0
Clay, with thin layers of soft, buff-coloured clay ; average	0	4
Great Oolite ; Kemble Beds :		
Limestones as at Southrop (p. 78), and Eastleach Turville Quarry (p. 73) ... ... seen for	5	0

The Forest Marble limestone, where shelly, recalls the highly shelly beds of the Eastleach Turville Quarry.

Clay, of which that seen in fissures in the Coln Lane Quarry is probably a remnant, floors a considerable area between Moor's Farm and Upper Moor's Barn (*i.e.* south of Dean Farm) about 1½ miles to the west. This tract, called Broadmoor, is heavy clay land, suitable, however, for sheep (p. 98). Typical false-bedded Forest Marble limestones with intercalated layers of blue-grey clay are exposed to a depth of 8 ft. in a quarry close to Upper Moor's Barn.

About a mile to the west of Broadmoor is Knoll Barn near which is the quarry described on p. 54 : it shows horizontally bedded Forest Marble limestone and clay resting on Kemble Beds obliquely bedded at high angles.

The Poulton Quarries on the west side of the road between Poulton village and Betty's Grave have long been abandoned. According to H. B. Woodward[1] : " At Poulton Quarry we find beneath from 2 to 4 feet of brown clay . . ., an alternating series, 12 feet thick, of obliquely bedded bands of oolitic limestone and grey clays. . . . The limestone or ' blue stone,' occurs in thin flags which are largely employed for roofing-purposes, under the name of ' Poulton Slates.' From these beds I obtained *Rhynchonella obsoleta, Lima cardiiformis, Pecten lens, P. vagans,* and a large *Gryphæa.*"

Nearby and little over half a mile north of Poulton Church there are two quarries, portions of which are still worked from time to time.

Quarries near Poulton

	Ft.	In.
Limestone, typical Forest Marble, with layers of greenish and (in the lower portion) brownish marl and clay ...	3	0
Clay, blue-grey, with thin, well separated layers of limestone (tile-stone) : in the southern quarry up to 3 ft. 4 in. ; in the northern quarry up to	6	0
Limestone ; splits into rough tile-stones ... seen for	3	0

A quarter of a mile farther north, on the north side of the Quenington road, or a quarter of a mile west of Betty's Grave, tile-stones are at present (1931) being actively worked.

Forest Marble clay forms very heavy ground around Ampney Knowle to the south of Barnsley and is to be seen (3 ft.) resting on limestone (5½ ft.) in an old quarry between the house and the Akeman Street.

A quarry a quarter of a mile north-east by east of Barnsley Church exposes 1 ft. 6 in. of typical Forest Marble limestone, flaggy, with abundant *Ostrea sowerbyi* Morris and Lycett ; on 4 ft. 4 in. of blue-grey clay with thin well-separated layers of limestone (tile-stones) ; on at least 5 ft. of massive limestones, locally full of fossils.

Hard, current-bedded limestones are quarried for road-metal, to a depth of 8 ft., a quarter of a mile west of Barnsley Church, and tile-stones are occasionally obtained.

The junction of the Forest Marble with the Cornbrash is exposed in a quarry south of Ampney Crucis Park (see p. 80).

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 369 and fig. 107, p. 370.

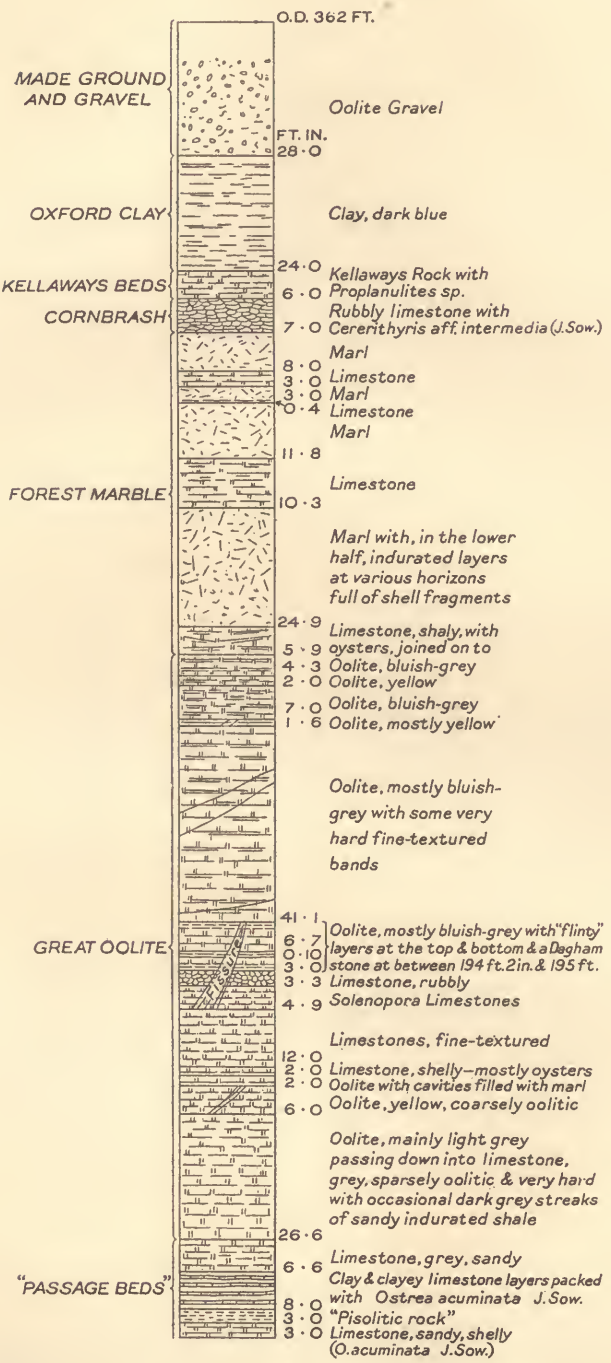

FIG. 3.—*Cirencester Urban District Council's Waterworks, Lewis Lane, Cirencester; 1924 Borehole.*

The thickness of the Forest Marble (Wychwood Beds) at Cirencester, as proved in the Lewis Lane borehole, is 66¾ ft., of which no less than 47 ft. 5 in. is marl that weathers to clay. The particulars of the beds proved in the boring are shown in Fig. 3 p. 75.

In the Forest Marble, limestone often passes into clay and *vice versa*. The basal portion of that in the boring must include the Bradford Clay, for from a 6-ft. bed of clay capping Great Oolite in a qaurry at Cirencester F. Bravender obtained ' *Waldheimia digona*.'[1]

Attention was first drawn, in 1847, to the occurrence of the Bradford Clay near Cirencester, by S. P. Woodward, then Professor of Natural History at the Royal Agricultural College : " with the assistance of my class I have obtained evidence of more than 100 species of marine animals having inhabited the sea-bottom (where now stands the Agricultural College) at the period this clay was accumulated." "Several specimens [of *Apiocrinus parkinsoni* Bronn] have been obtained by Mr. Gotz, a student of the College, at the lime kiln quarry in Perrymoor "[2] about half a mile to the north-west by west.

The lowest 24-ft. clay-bed of the Forest Marble Series is partly exposed above the Kemble Beds in the north side of the cutting on the Stroud road north of the College, and at the top of an old quarry in Cirencester Park, nearly a mile west by north of Cirencester Church.

A little to the west-north-west of Fourmile Lodge, Sapperton, near the 10th milestone from Stroud on the Stroud-Cirencester road, is a quarry in Forest Marble and Kemble Beds, which exposes the section given below :—

Quarry near Fourmile Lodge, Sapperton

	Ft.	In.
Forest Marble ; Wychwood Beds :		
Limestone, flaggy, locally false-bedded ... seen for	2	0
Clay	0	2
Limestone, flaggy, with abundant *Ostrea sowerbyi* Morris and Lycett, *Camptonectes laminatus* (J. Sowerby), *Camptochlamys obscura* (J. de C. Sowerby), *Chlamys vagans* (J. de C. Sowerby), *Exogyra crassa* (Wm. Smith), *Lima cardiiformis* Morris and Lycett, *Placunopsis socialis* (Morris and Lycett), *Trigonia* of *flecta* group, *Kallirhynchia sp.*	3	2
Marl, clayey, brownish ; abundant *O. sowerbyi* Morris and Lycett...	0	6
Great Oolite ; Kemble Beds :		
Limestone, hard, locally a good oolite ... seen for	4	0

The 6-in. bed of marl at the base of the Forest Marble may be the equivalent of the Bradford Clay.

In a quarry on the east side of the line and west of the railway bridge over the Fosse Way at the old Tetbury Road Station (now only a goods' station) the Bradford Clay is about 2 ft. thick, but as it is traced to the north it is seen near the signal-box to be but 3-6 in. thick and to contain lenticles of white rubble, *Ostrea sowerbyi* Morris and Lycett, *Chlamys vagans* (J. de C. Sowerby), etc.

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[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 284.

[2] ' On the Geology of the district explored by the Cotteswold Club and more particularly the clay subsoil of the College Farm,' *Proc. Cotteswold Nat. F. C.*, vol. i, 1853, p. 6. See also J. Buckman, ' On the Oolite Rocks of Gloucestershire and North Wilts,' *Quart. Journ. Geol. Soc.*, vol. xiv, 1858, p. 107. Perrymoor is marked on the Old Series Geological Survey Map, Sheet 34.

CHAPTER VI

CORNBRASH AND OXFORD CLAY

Cornbrash

The main outcrop of the Cornbrash traverses the southern portion of the district by way of Preston, Poulton, Fairford, Southrop and Broughton Poggs, and a small faulted-in mass occurs beneath a part of Cirencester.

In 1928 Dr. J. A. Douglas and Dr. W. J. Arkell contributed a valuable paper on ' The Stratigraphical Distribution of the Cornbrash : I. The South-Western Area,'[1] in which they described many sections in detail, correlated the beds exposed, and proved that the sequence of brachiopod zones and intraformational erosions, put forward by the late S. S. Buckman in his paper of the preceding year on ' Some Faunal Horizons in Cornbrash,'[2] were largely based on inadequate evidence and that therefore a number of his conclusions required revision.

When introducing the table of brachiopod zones of the Cornbrash, reproduced below, Douglas and Arkell stated (*loc. cit.*, p. 125) : " Several suggested zones have purposely been omitted, rather than that they should be inserted prematurely on insecure or insufficient evidence. Others have been placed in brackets as a definite indication of where further additions may be expected. For the present these must be regarded as tentative."

Brachiopod Zones of the Cornbrash

Upper Cornbrash	*Microthyris lagenalis* (*Microthyris sublagenalis*) *Microthyris siddingtonensis* *Ornithella arenaria*	*Rhynchonelloidea-cerialis* group
Lower Cornbrash	(*Ornithella classis*) *Ornithella-obovata* group (*Cererithyris dorsetensis*) (*Ornithella magnobovata*) *Cererithyris-intermedia* group	*Kallirhynchia-yaxleyensis* group *Kutchirhynchia idonea*

According to Douglas and Arkell (*op. cit.*, p. 121) : " Where the junction of the Forest Marble and Cornbrash is visible, the zone of *C. intermedia* is almost invariably present, although it differs greatly in development even within strictly local limits."

[1] *Quart. Journ. Geol. Soc.*, vol. lxxxiv, 1928, pp. 117-178 and pls. ix-xii.
[2] *Quart. Journ. Geol. Soc.*, vol. lxxxiii, 1927, pp. 1-37 and pl. i.

" The ' obovata ' zone is probably the most widespread and the most fossiliferous of the Lower Cornbrash, and at the same time it exhibits the greatest variation in lithological characters."[1] (*Op. cit.*, p. 122).

The Zone of *Microthyris lagenalis* " . . . is best developed in the Fairford district, where the index-fossil occurs in great abundance in association with *Rhynchonelloidea cerealis*. Here the sequence appears to be complete, the ' *lagenalis* ' beds overlying others crowded with *Microthyris ' siddingtonensis.'* In many other localities, however, there has been intraformational erosion, and the zone is found lying non-sequentially on beds of Lower Cornbrash age." (*Op. cit.*, p. 124).

Locally fossils that should succeed one another vertically are found intermingled. To explain such occurrences Douglas and Arkell suggest intraformational erosions : thus there may have been local contemporaneous erosion of the Intermedia Zone in hemera *obovatae* at Farhill, near Fairford (p. 79), and Lower Cornbrash fauna appears to be mixed at Shorncote (*op. cit.*, p. 135).

Details

At a point three-tenths of a mile S.18°W. of Southrop Church the junction of the Cornbrash with the underlying formation is to be seen in a large quarry the section in which has been also described by Douglas and Arkell (*op. cit.*, p. 133).

Southrop Quarry

	Ft.	In.
Lower Cornbrash :		
Obovata Zone. Limestone, flaggy ; *Ornithella obovata* (J. Sowerby), *O. grandobovata* S. Buckman, *Chlamys vagans* (J. de C. Sowerby), *Limea duplicata* (J. de C. Sowerby), *Lopha costata* (J. de C. Sowerby), *Exogyra sp.*, *Pleuromya decurtata* (Phillips), etc. ... seen for	2	0
Intermedia Zone. Limestone, cream coloured (appearing as a white band at a distance), crowded with *Cererithyris intermedia* (J. Sowerby) ; *Chlamys vagans* (J. de C. Sowerby), *Ostrea sowerbyi* Morris and Lycett, *Pleuromya decurtata* (Phillips)	0	10
Great Oolite ; Kemble Beds :		
Limestone, compact, grey and brown, oolitic, false-bedded	2	0
Sandy ' marl,' locally greenish-yellow, passing into irony, sandy limestone (0 to 1 ft.)	0	6
Limestones, as above ... ... seen for	5	0

Douglas and Arkell recorded the beds upon which the Cornbrash rests as Forest Marble, but remarked that " The clay which forms the top of the Forest Marble at Brize Norton is here absent and the ' *intermedia* ' bed lies directly upon an uneven surface of false-bedded limestone " : I incline to the opinion that they are Kemble Beds (see p. 73).

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[1] Dr. Arkell informed me (*in litt.*, 10th January, 1930) : " We always regarded the *Obovata* Zone as carried down as far as the lowest occurrence of *obovata*, and classed any barren massive crystalline limestones below this limit according to their lithological appearance. Some sign of *Cererithyris intermedia* was generally to be found on making a close search."

The Obovata Zone is exposed in a large shallow quarry 1¾ miles east-north-east of the Southrop Quarry; while half a mile south of this exposure (or half a mile south-west of Broughton Poggs) higher beds are imperfectly displayed, as under :—

Quarry S.W. of Broughton Poggs

	Ft.	In.
Soil with a fragment of *Microthryis lagenalis* (Schlotheim)	—	—
Upper Cornbrash :		
Siddingtonensis Zone. Rubble, marly, with an admixture of clay containing decayed nodules composed of *Microthyris siddingtonensis* (Walker) ; also *Kamptokephalites herveyi* (J. Sowerby), *Gresslya peregrina* (Phillips), *Anisocardia minima* (J. Sowerby), *Lopha marshi* (J. Sowerby), *Pseudomontis echinata* (J. Sowerby), *Nucleolites clunicularis* (Smith), and *Holectypus sp.*	1	0
Sandy, ferruginous layer	0	3
Limestone, flaggy, grey to purplish ... ... seen for	3	0

Of the lowest beds seen in this quarry Douglas and Arkell remarked (*op. cit.*, pp. 132, 133) : " These grey to purplish flags, of an almost flinty hardness, are a regular feature of the Upper Cornbrash from this district to that of Fairford and Poulton. They yield few fossils other than the zonal index *Microthyris siddingtonensis*, which occurs sparingly."

Two miles due west of the Southrop Quarry and on the east side of the road near Farhill Farm is a quarry displaying lower beds :—

Quarry near Farhill Farm

		Ft.	In.
Lower Cornbrash :			
Obovata Zone	1. Limestone, grey, compact, slightly oolitic and shelly seen for	1	0
	2. Marl and stone with abundant *Cererithyris intermedia* (J. Sowerby) ; *Ornithella obovata* (J. Sowerby), *Pleuromya decurtata* (Phillips)	1	0
? Intermedia Zone	3. Clay, green, irregular	0	3
	4. Limestone, grey, crystalline, weathering slightly sandy; seen for	2	6

Dr. Arkell suggests to me that bed 4 " may be an unfossiliferous residue of the Intermedia Zone, most of which is represented rearranged in *obovata* times, in bed 2." Half a mile farther north-west by west is another shallow quarry displaying similar beds.

In Milton End, Fairford, on the north side of the road near the 8th milestone from Cirencester is the site of[1] the ' Milton End, Fairford ' quarry of Douglas and Arkell (*op. cit.*, p. 134). These authors described the quarry as situated a " short distance north-west of the town," but Dr. Arkell informs me that it is " exactly half a mile west-south-west of the Church." Douglas and Arkell's record is repeated below with my additions in square brackets.

Milton End Quarry, Fairford

		Ft.	In.
Soil		0	6
Pleistocene gravel, with fragments of Forest Marble and Great Oolite corals. [One quartzite pebble observed]		0	8
Upper Cornbrash :			
[Lagenalis Zone]	5. Laminated brown marl, with crushed specimens of *Microthyris lagenalis* and a small *Ostrea*	1	6

[1] The quarry-face has been sloped, and a grass-covered depression now alone marks the site of the quarry. Temporary quarries are opened here when stone is required.

		Ft.	In.
	4. Limestone yielding abundant *M. lagenalis, M. triquetra, M. sublagenalis*, and closely allied forms; abundant *Rhynchonellooidea cerealis, Rh. gremifera, Rh. laevis* [Douglas and Arkell], and allied forms, *Anatina siliqua* ... ... 18 in. to	2	0
	3. Soft brown marl crowded with *M. lagenalis, Rh. cerealis* etc., also *Pleuromya lyrata, Modiola bipartita*, and *Gresslya peregrina*. [*M. calloviensis* Douglas and Arkell, *M. siddingtonensis* (Walker), *M. sublagenalis* (Davidson), *Serpula tetragona* J. de C. Sowerby, *Nucleolites orbicularis* (Phillips), *Isastraea sp.*]	1	10
[Siddingtonensis Zone]	2. Highly fossiliferous limestone; a mass of *M. siddingtonensis*; *Rhynchonelloidea cerealis* rare...	1	0
	1. Hard, blue-hearted limestone. A few specimens of *Microthyris siddingtonensis* ... seen to	0	6

Douglas and Arkell's types of *Ornithella miltonensis, Microthyris calloviensis* and *M. subcalloviensis* came, so Dr. Arkell informs me, "probably all from bed 3. They were selected from enormous numbers weathering out of soft marl on the tip heap." *M. calloviensis* has been obtained *in situ* (see above record, bed 3). These authors state that this quarry is "remarkable for the abundance and beautiful preservation of its fossils. The section affords a small though excellent exposure, unequalled in the South-Western area, of both the '*siddingtonensis*' and '*lagenalis*' zones of the Upper Cornbrash."

There is an old quarry in the Obovata Zone 1¼ miles E. 15° N. of Poulton Church.

A quarry south of Ampney Park, on the south side of the Cirencester-Fairford road near the 2nd milestone from Cirencester shows the following section:—

Quarry S. of Ampney Park, Ampney Crucis

	Ft.	In.
Lower Cornbrash:		
Obovata Zone. Limestone, rubbly, and marl; *Ornithella obovata* (J. Sowerby) abundant along a line 2½ ft. above the base. No sign of *Cererithyris intermedia* (J. Sowerby); only *O. obovata* seen in lower part ... seen for	5	0
Forest Marble:		
Clay	5	0
Limestone, false-bedded ... ... seen for	20	0

This section has been noticed by Prof. James Buckman,[1] H. B. Woodward,[2] and the writer.[3]

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[1] 'On the Oolitic Rocks of Gloucestershire and North Wilts,' *Quart. Journ. Geol. Soc.* vol. xiv, 1858, p. 119.

[2] 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 367.

[3] 'Geology in the Field,' 1910, p. 352.

The 1924 borehole at the Lewis Lane Pumping Station, Cirencester, proved (in the faulted-in mass of rocks beneath the Works) the occurrence of Cornbrash (with *Cererithyris intermedia* (J. Sowerby) and *C. ovalis* S. Buckman) 7 ft. thick, resting on Forest Marble clay.[1]

Oxford Clay

Oxford Clay floors a small tract in the south-eastern corner of the district, but there are no exposures worthy of record and there is no topographical feature that might indicate the presence of hard Kellaways Rock. The 1924 borehole at the Lewis Lane Pumping Station, Cirencester, proved the occurrence of dark blue Oxford Clay (24 ft.) and typical Kellaways Rock (6 ft.).

[1] Richardson, L., ' Excursion to Cirencester and District,' *Proc. Geol. Assoc.*, vol. xxxvi, 1925, p. 96 ; ' Wells and Springs of Gloucestershire ' (*Mem. Geol. Surv.*), 1930, p. 185.

CHAPTER VII

SUPERFICIAL DEPOSITS

The district as a whole is remarkably free from drift, and, with the exception of the south-eastern part there are no extensive spreads. The only deposits remaining as evidence of ice-action are of a residual character and, though widespread, are seldom exposed. Of the chief rivers which drain the district, there are the upper reaches only of the Churn, Coln and Leach, and a short stretch of the Windrush, and the paucity of deposits associated with them renders correlation with deposits in the Thames drainage system a matter of conjecture. The spreads of gravel between Fairford and Broughton Poggs are merely the extreme edge of wide spreads which cover the flat area of Oxford Clay to the south around Cricklade and Lechlade. According to Mr. Dines,[1] who mapped the Superficial Deposits for the purpose of the new map and drew up the list given below, "it therefore appears necessary, in dealing with the superficial deposits of the district, to restrict observations to descriptions of the deposits and to their apparent sequence as shown by evidence within the district: it would appear unwise to attempt correlation with deposits in other localities."

The following is a list of the Superficial Deposits:—

Alluvium.	In most cases in the river valleys this consists mainly of limestone gravel.
Terraced River Gravels.	Of rare occurrence.
Older Alluvium.	A loamy clay containing stones on the Oxford Clay plain in the south-east corner of the district.
Gravels of the Plain { Lower / Higher }	Extensive deposits of gravel on the Oxford Clay plain.
Boulder Clay.	Remnants only.
Cheltenham Sand and Gravel.	Interbedded quartzose sand and limestone gravel.
Downwash Gravel.	One small patch near Andoversford.

Downwash Gravel

Though of widespread occurrence in the Moreton in Marsh district, only one small patch of this gravel lies within the present district, near Andoversford. The date of the Downwash Gravel is a matter of uncertainty. There seems little doubt that many of the occurrences in the Moreton in Marsh area are amongst the

[1] Mr. Dines contributed the paragraphs to which his initials are appended.

oldest Superficial Deposits in the district, but that near Andoversford may be of later date: it may be a sludge deposit formed during the close of the Glacial period. [H.G.D.]

Rough limestone gravel, formed—especially in the basal part—of large pieces of angular to subangular limestone (Marlstone and Upper Lias and Inferior Oolite), that may be of the date of the Downwash Gravel, has been worked close to where the Southfield Brook goes under Sandy Lane, Charlton Kings (329·9 ft. O.D), and emerges from beneath the Cheltenham Sand around (*a*) Southfield Farm (349 ft. O.D.) and (*b*) Lilley Brook (337·3 ft. O.D.).[1]

Cheltenham Sand and Gravel

The southern extremity of the large spread of the deposit on which Cheltenham is situated enters the district in the north-west corner near Lilley Brook. Farther east, near the Dowdeswell Reservoir, a patch, with its base 10 ft. above the present valley bottom, consists of limestone gravel without quartz or sand. This is undoubtedly of the same date as the Cheltenham Sand farther west, but being well up the Chelt valley, was shut off from the supply of sand which entered the neighbourhood down the Vale of Evesham. [H.G.D.]

Details

The Cheltenham Sand and Gravel is being actively worked on the south side of the railway, half a mile west of Charlton Kings Station. The section shows 1 ft. of grey loamy sand on 1-3 ft. of pale brown loam piped into the surface of 15 ft. of limestone gravel with seams of pink quartzose sand.[2] The soil on the Cheltenham Sand deposit consists of a very light sandy loam, which is quite unique in the district. Coxhorne Pit, about a quarter of a mile west of the Dowdeswell Reservoir, displays brown soil, 1 ft., on even-bedded limestone gravel with, in one place at 3 ft. from the top, a thin lenticle of clay, 7-9 ft. The gravel, which is unaccompanied by quartzose sand, consists of subangular pebbles of oolite (with an occasional pebble of Middle Lias ironstone and Upper Lias limestone and a fair number of rather worn belemnites) with a matrix of 'oolite sand' (de-cemented Oolite). Lucy remarked[3] that on the road to Andoversford "... near the fourth milestone from Cheltenham ... is a large bed of sub-angular Oolitic Gravel (with some Marlstone) at least 10 ft. thick," and Gray[4] pointed out that "... in a pit near Coxhorne at 300 ft. [nearer 320 ft.] O.D. the [Cheltenham] sand[5] occurs only in thin seams and small pockets in the Jurassic gravel. Thence the sand gradually thins out and it is found sparingly mixed with the gravel at the Dowdeswell Reservoirs, at a height of about 370 ft. O.D."

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[1] Richardson, L., 'Memoir Explanatory of a map of a Part of Cheltenham,' *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, pl. xvi, and p. 133.

[2] See 'The Country around Moreton in Marsh' (*Mem. Geol. Surv.*), 1929, p. 125 and plate v.

[3] Lucy, W. C., 'The Gravels of the Severn, Avon and Evenlode, and their extension over the Cotteswold Hills,' *Proc. Cotteswold Nat. F. C.*, vol. v, 1872, p. 89.

[4] Gray, J. W., 'The Lower Severn Plain during the Glacial Epoch,' *idem*, vol. xvii, pt. 3, 1912, p. 371.

[5] Probably the sand noticed by Gray was 'oolite sand' and not quartzose sand.

Boulder Clay

In various localities on the uplands erratics of quartz, quartzite and flint are to be found fairly commonly scattered in the soil. These appear to be the only visible evidence of a former widespread occurrence of boulder-clay on the Cotteswolds. At Tangley,[1] in a limestone quarry at 625 ft. O.D., is a fissure filled with yellow-brown clay with quartzite and flint ' boulders ' (Plate VI, A, B). It is most probable that there exist similar fissures or pockets in limestones, filled in with boulder-clay, and that these are the source of supply of the erratics which occur in the soil. [H.G.D.]

The Plateau Drift referred to in ' The Geology of the Country around Oxford '[2] is in most cases boulder-clay correlative with the Tangley deposit.

Details

Northern pebbles, *i.e.* pebbles of quartz, quartzite, etc.—the Northern Drift—have been observed at the following sites :—

1. On Taynton Downs,[3] as recorded by Hull on the Geological Survey Map, Sheet 44 (Old Series), and thence, as observed by Lucy, " along the ridge of high ground as far as Stow-on-the-Wold."[4] Also in the top soil of quarries in the Chipping Norton Limestone in the Rissington country.
2. On the Great Oolite tract around the 12th milestone from Cirencester on the Fosse Way in the direction of Bourton on the Water at 657 ft. O.D. (Lucy : map accompanying his 1872 paper).
3. In the vicinity of the cross-roads east of New Barn Farm (formerly New Barn Inn) east of Northleach at 624 ft. O.D., and thence along the Burford road as far as Burford (Lucy : map.) The northern material is represented by Lucy on his map as being associated with Oolite (or limestone) Gravel.
4. Around Hangman's Stone, 1½ miles west by north of Northleach at 705 ft. O.D., where—according to Lucy (map)—pebbles are " very sparingly scattered."
5. North-east of Fairford, as, for example, on a field on Cornbrash 1 mile to the north-east of Fairford Church, where northern material—mostly Bunter quartzite pebbles—occurs as scattered pebbles, as noted by Hull (map).[5]
6. North-west by north of Fairford.
7. On a field at Ampney Crucis (There are some large liver-coloured quartzite pebbles on a window sill in the village which are said to have been picked up off this field.—L.R.).

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[1] Callaway, C., ' The Occurrence of Glacial Clay on the Cotteswold Plateau,' *Geol. Mag.*, 1905, p. 218. See also L. Richardson, ' Excursion to . . . Burford,' *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 1, 1907, pp. 28, 29 ; *idem*, vol. xxiii, pt. 1 for 1927, 1928, p. 13 ; H. G. Dines, 'On the Glaciation of the North Cotteswold Area,' 'Summary of Progress' for 1927 (*Mem. Geol. Surv.*), 1928, pp. 68, 70.

[2] *Mem. Geol. Surv.*, 1926, p. 106. The Cirencester district is included in the area dealt with by Dr. K. S. Sandford in his paper on ' The Erratic Rocks and the Age of the Southern Limit of Glaciation in the Oxford District,' *Quart. Journ. Geol. Soc.*, vol. lxxxv, 1929, pp. 359-88 and plate xxii.

[3] Bunter pebbles, etc., are numerous just east of the area represented on Sheet 235 in the vicinity of the junction of the road from the disused Taynton Quarries with the Stow-Burford road.

[4] *Proc. Cotteswold Nat. F. C.*, vol. v, 1872, p. 104.

[5] Hull, E., ' On the Physical Geography and Pleistocene Phenomena of the Cotteswold Hills,' *Quart. Journ. Geol. Soc.*, vol. xi, 1855, p. 479.

A.—BOULDER CLAY FILLING FISSURE IN GREAT OOLITE, IN QUARRY 1 MILE SOUTH OF FIFIELD. THE CLAY CONTAINS PEBBLES OF NORTHERN MATERIAL.

B.—CLOSER VIEW OF PART OF THE BOULDER CLAY SHOWN IN A.

8. On a field about three-quarters of a mile north-west of Sheephouse Farm—a mile west of Barnsley (A small Bunter quartzite pebble.—L.R.).
9. In the vicinities of the cemetery and Chesterton, Cirencester (Unconfirmed record by Lucy : map).

Localities at which ' Northern Drift ' pebbles have been found in later Superficial Deposits include :—

10. A pit in Terraced River Gravel toward the southern end of the Vale of Bourton.
11. Between Bibury and Ablington (? in R. Coln gravel. Unconfirmed record by Lucy : map).
12. Quarry (now overgrown) in Cornbrash near the 8th milestone from Cirencester in Milton End, Fairford, in capping of Lower Gravels of the Plain (One Bunter quartzite pebble.—L.R.).
13. Between Fairford and Poulton (Lucy : map). At the turning to Meysey Hampton from the Cirencester-Fairford road is a pit in Oolite (or limestone) Gravel belonging to the Higher Gravels of the Plain, in which quartz, quartzite, flint and sandstone (Sarsen Stone) pebbles are not uncommon.

Lucy observed[1] : " On the high ground above Bourton [on the Water] is N[orthern] D[rift], but from thence to Northleach it was only after a diligent search that I was enabled to pick up some scattered pieces, and they were mostly square, or slightly rounded, Millstone Grit ; and the same was the case from Burford to Northleach."

Gravels of the Plain

The Oxford Clay country to the south of the district forms a wide flat plain which is extensively covered with drift. Part of the northern edge of this plain enters the south-east corner of the present district. The gravels on this area have, for lack of a more suitable name, been termed the ' Gravels of the Plain.' They can be separated into two classes :—

1. *Higher Gravels of the Plain.*—

   Between Poulton and Fairford there are spreads of gravel consisting mainly of limestone pebbles, but in which quartz, quartzite, flint and sandstone pebbles are common. These spreads occur at 330-350 ft. O.D. (top), 50-70 ft. above the Lower Gravels of the Plain, and appear to be the remnants of a once more extensive deposit.

2. *Lower Gravels of the Plain.*—

   These extend from Fairford to the eastern margin of the area. They consist of well worn limestone fragments, erratics are very rare, and their height above O.D. varies between 260 and 280 ft. (top) [H.G.D.]. They may be a westward continuation of the ' Second ' or Summertown-Radley Terrace of the Oxford District [2] [L.R.].

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[1] *Proc. Cotteswold Nat. F. C.*, vol. v, 1872, p. 104.
[2] ' The Geology of the Country around Oxford ' (*Mem. Geol. Surv.*), 1926, p. 127.

DETAILS

Higher Gravels of the Plain are well exposed in a pit at the turning to Meysey Hampton from the Poulton to Fairford road about 1¾ miles east of Poulton. It lies about 200 yards south of the southern margin of the district and shows 6 in. of grey-brown, silty clay on 5 ft. of compact limestone gravel of an average grade of about 2-in. mesh, but with some larger pebbles. Large pebbles of quartzite, quartz and sandstone are common. The upper part of the gravel is contorted and festooned, and in places the pebbles rest with their longer axes vertical. Another pit, in the small patch near the trigonometrical station at 356 feet, exposes 6 in. of grey-brown loamy clay resting on irregular pockets of red-brown clay up to 1½ ft. deep here and there, in 2-5 ft. of distorted limestone gravel with pebbles of quartzite and micaceous sandstone. The junction with the underlying limestone is visible in the pit, and dislocated flags in the upper part of this are caught up here and there in the lower part of the gravel.

There are old pits in the spreads west and north-west of Fairford but these are overgrown and afford no exposures. The soil of the country around these spreads contains numerous northern erratics and it is difficult to determine exactly the boundaries of the deposit.

Lower Gravels of the Plain are worked in pits near Fairford. The cutting for the railway terminus is in gravel and just east of the station a pit (264 ft. O.D.) shows 9 in. of grey-brown loam with a few small scattered limestone pebbles ; 0-1½ ft. of russet-grey loam with no stones (probably Older Alluvium) ; on 4 ft. of white, bedded gravel of well-worn limestone pebbles with no northern stones. There is little or no matrix, but when it does occur it consists of calcareous sand. Thin horizontal streaks of orange-coloured staining are present. From here to beyond Thornhill Farm there is a spread of alluvial loamy clay which masks the gravel, rendering the tracing of the boundary less certain, but exposures in ditches and beneath uprooted trees show the spread to be continuous. Passing eastward the next good exposures are near Lechlade Station : one south of the road-bridge over the railway on the east side of the road ; another to the north on the west side of the road. The former displays 6 to 8 ft. of gravel, in the lower part of which waterworn belemnites derived from the Oxford Clay are not uncommon ; the latter shows the following section :—

Lechlade (or Foxfield) Gravel Pit

	Ft.	In.
Soil, grey-brown—a median loam	0	6
Soil and small limestone pebbles	0	6
Oolite Gravel, festooned and contorted, white, composed of well waterworn fragments of Great Oolite and Forest Marble limestones with a considerable admixture of 'oolite sand'	3	0
Oolite Gravel as above, but not contorted... seen for	3	0

Water occurs in the pit at 7 ft. from the surface. Streaks of orange colour follow the bedding or the festoons here and there. No quartzite pebbles have been noted here, but one small flint chip about 1 in. in length, slightly rolled and patinated white, has been found in the upper contorted part at about 3 ft. from the surface.

There are a few small pits in the spread north-west of Little Faringdon, between the road and the River Leach. These show up to 4 ft. of limestone gravel : no northern stones have been observed. There are old pits in the small spreads on either side of the stream at Broughton Poggs, but exposures here are nearly obscured. [H.G.D.]

The Older Alluvium

Covering the Oxford Clay plain to the south of the present Sheet is a thin though persistent spread of clay containing a few scattered stones—mostly ochreous waterworn flints. This is seldom over 2 or 3 ft. in thickness, but it covers the plain, in some cases completely masking spreads of gravel. Too small an area of this deposit has been surveyed, and too few data collected, to enable a definite idea of its mode of formation to be arrived at. It appears to resemble an alluvial spread of later date than the Lower Gravels of the Plain, which it overlies, and of earlier date than the recent alluvium of the present streams, which cut into it. It may have been the result of ponding of water on the plain,[1] or the occasional inundation by rivers which drain it. A point of evidence against regarding this as an alluvium is the presence in it of flints, often 4 or 5 in. in length and in fair numbers.[2] These occur close to the northern margin of the deposit, at the foot of the dip-slope of the Jurassic limestones where there is no possibility of the flints having been derived locally even from the gravels. This deposit has been shown on the map in the area between Little Faringdon and Broughton Poggs, where it apparently covers the Oxford Clay. It also occurs overlying spreads of gravel, although it is not always present. For this reason the gravels have been given preference on the map and the Older Alluvium shown only where it rests directly on Oxford Clay or is of sufficient thickness to mask any gravel spreads present. In some small exposures a thin bed of gravel has been noted between the Older Alluvium and the underlying solid formation. [H.G.D.]

The Terraced River Gravels and Alluvium

The rivers draining the district have their catchment basins within an area consisting mainly of limestones and, in consequence, the bulk of the Alluvium is of a gravelly nature. Most of the alluvial tracts shown on the map consist of gravel with a covering of alluvial silt. Only in a very few cases have terraced deposits been left above the present level of the rivers. These occur in Chedworth Woods on the Coln, at Baunton on the Churn, and near Sherborne and Great Rissington on the Windrush.

[H.G.D.]

Details

Terraced River Gravels of the Churn occur at Baunton, where a spread occupies the convex side of a meander curve on the east side of the river and lies only 4 or 5 ft. above the alluvial flat. A small pit shows 2½ ft. of dark brown loam with limestone fragments, separated by 2½ ft. of red-brown clay with very few stones from 4 ft. of bedded limestone gravel. Two small

[1] The possibility of a Lake Oxford has been suggested by the late F. W. Harmer, see *Quart. Journ. Geol. Soc.*, vol. lxiii, 1907, p. 494.

[2] Quartzite pebbles have been noted on this deposit; they may have been derived from the area of Jurassic limestones, either from the remanié Boulder Clay or from the Higher Gravels of the Plain. The flints are too abundant, however, to have come from the same source. Limestone pebbles, of course, occur sporadically in the clay near the limestone outcrops and the gravels.

patches of terraced gravel occur in the Coln valley in Chedworth Wood. One on the west of the river two-fifths of a mile north-east by north of the Roman Villa is 10 ft. (base) above the stream level, and a pit in it shows 6 ft. of bedded limestone gravel, generally buff-coloured but occasionally pink. Some of the beds, up to 1 ft. in thickness, are indurated in places. Below the top soil are pockets of red-brown loam, a foot or more deep in the gravel, that contain minute fragments of limestone. A quarter of a mile farther south, and on the opposite side of the river, is another but smaller spread, a few feet only above the river level and but poorly exposed. In the Vale of Bourton, which is traversed by the Windrush, there are two terraces, a higher one on the west of the stream, east-north-east of Sherborne, at 10 or 12 ft. (base) above the level of the stream ; and a lower one, north-west of Great Rissington, 0 to 5 ft. (base) above stream level. The former (about 390 ft. O.D.) has been worked, and the pits, now disused, show 1-2 ft. of brown, loamy clay on 3 ft. of compact limestone gravel with, locally, lenticles of ' sand ' and occasional small pebbles of quartz and quartzite. A number of worked flints (Neolithic) was obtained here. In the lower terrace a small excavation exposes 3-4 ft. of limestone gravel with a comparatively high proportion of calcareous sand. The gravel is usually water-logged at 3 ft. from the surface.

Alluvium in the Churn valley[1] extends as far up-stream as Cowley, and up two tributary streams, one passing through Bagendon and the other through Stratton, Daglingworth, and Duntisbourne Rouse. The only exposures are near Cirencester. A pit near the mill one mile south of Baunton is in 3 ft. of brownish-grey loam on limestone gravel, water resting at about 4 ft. from the surface. There is a fairly large pit (360 to 370 ft. O.D.) in the grounds of The Barton about a quarter of a mile north-west of Cirencester House. This is near the margin of the alluvium and shows the following section :—

The Barton Gravel Pit, Cirencester

	Ft.	In.
Grey loam	0	6
Buff loam, homogeneous, with a few scattered limestone pebbles, descending in pockets into ... ... 0 to	2	0
Current-bedded limestone gravel in beds of varying grades ... ... 1 to	1	3

Water rests at 5 ft. from the surface of the gravel. No other exposures are known to exist. The fields on the alluvium around Cirencester all show a dark peaty loam of uncertain thickness, but sometimes exceeding 4 ft. Boring records in the town show up to 30 ft. of gravel beneath the alluvial loam.

The alluvium of the River Coln runs continuously across the district from Andoversford to Fairford, with a narrow strip following the small tributary valley from Compton Abdale. There are pits, either old or in intermittent use, sunk in the alluvium at Coln St. Dennis, Calcot, Ablington, Bibury, between Bibury and Coln St. Aldwyn, at Coln St. Aldwyn, and at Hatherop. Most of these show one to two feet of grey or peaty alluvial loam or silt on water-logged limestone gravel. The only exposure which calls for special note is in the grounds of Hatherop Castle and is situated in the middle of a fairly wide stretch of alluvium :—

Gravel Pit, Hatherop

	Ft.	In.
Grey clayey loam	0	6
Brownish-buff clayey loam with small limestone fragments	0	6
Ditto, with larger limestone fragments	0	6
Fine calcareous sandy gravel, rather loamy, containing unbroken specimens of freshwater and land snails ...	1	6
Black or grey-brown peaty loam	0	3
Clean limestone gravel	3	0

[1] Many meadows on this Alluvium are true water-meadows—meadows specially irrigated to produce an early crop of hay. One such water-meadow is that on the right bank of the river three-fifths of a mile south of the bridge in North Cerney village.

Water rises in this pit to 4 ft. from the surface. The black peaty loam at 3 ft. from the surface is an old land surface and marks successive stages of deposition. Only the bottom clean gravel is excavated for use. A sharp worked flake of flint, patinated white, was found on a heap of screened gravel close to this pit by Mr. Dines, who says : " It almost certainly came from the bottom gravel. It appears to have a flat (not facetted) platform, but otherwise has no distinguishing points by which it can be assigned to any particular culture stage. It may belong to any stage from that of Aurignac onwards."

The alluvium of the Leach stretches from Northleach to Little Faringdon. Where it passes on to the area of the Older Alluvium it is separable from that deposit by a slight feature, its level being a few feet lower. Gravel pits have been opened in this alluvium about a quarter and half mile respectively up stream from Eastleach Turville. Both show much the same section, that of the lower one near the windpump between the 300-ft. contour-line and the river being as under :—

Gravel Pit near Eastleach Turville

	Ft.
Pale brown silty clay	1
Brown clay with scattered stones	1½ to 2
Oolite (or limestone) gravel with earthy matter and locally lenticles of calcareous sand ... seen for	3

The limestone gravel is water-logged. The sand of the lenticles looks like siliceous sand, but when treated with acid leaves very little insoluble residue. Sand for sanding floors was obtained from the upper pit, but the deposit is said to be worked out.

The widest areas of alluvium belong to the Windrush around its confluence with the Dikler to the west of Great and Little Rissington. No gravel appears to have been excavated from this occurrence, but there is a small disused pit on the Sherborne Brook half a mile east of Farmington Lodge. Locally, in the Vale of Bourton, as on the west side of the Dikler, three-quarters of a mile west of Little Rissington (where the number 410 is on the map), it contains thin layers of peat (see p. 100, locality 17).

In addition to the strips of alluvium alongside the main streams of the district there are alluvial stretches alongside a number of smaller streams along the southern margin of the district, the chief of which is that of the Ampney Brook. In this there is an old gravel pit close to the stream just north of Ampney Park which shows 9 in. of grey-brown loamy clay, on 3 ft. of pale coffee-brown clay with limestone fragments, and this on water-logged limestone gravel. Hull shows his ' Estuarine mammaliferous gravel ' on his map[1] in a position that suggests the depression in which the Ampney Springs rise, but there is only the deposit referred to above between the Springs and the Akeman Street.

The Dry Valleys[2]

The upland area of the Cotteswolds consists of a gently sloping plain, the dip-slope of the Oolites, falling from over 1,000 ft. O.D. at Broadway Hill in the north, to about 300 ft. O.D. along the margin of the Oxford Clay district in the south. Broadly speaking this plain is flat, but, in addition to the present stream valleys, it is dissected by many ramifying dry valleys which commence in the higher parts of the country, where no water supply is now available, and, from these upland areas, plunge steeply down

[1] *Quart. Journ. Geol. Soc.*, vol. xi, 1855, p. 479.
[2] By H. G. Dines.

sometimes to form deep gorge-like valleys or coombes. These may, in part, be due to solution of limestone, but as already pointed out in respect of the valleys of the North Cotteswold area[1] water from a melting snow or ice-cap was a more likely cause of their formation. It is difficult to conceive what other agency could be responsible for the initiation of a group of valleys radiating from a small area of high ground, as is so frequently the case in the Cotteswolds (*e.g.* the groups of radiating valleys in the north-west part of the district, see map, Fig. 1). From the manner in which the heads of the dry valleys are clustered together in a small area from which the valleys radiate it is highly improbable that they were fed by springs from underground sources.

Further evidence in support of this view is the fact that many of the dry valleys are hanging often 20 or 30 ft. above the level of the present stream valley floors. In most cases the junction of the two is modified so that no sharp or striking feature occurs, but in some cases the drop at the mouth of the hanging valley is subdued to only a moderate extent—as, for example, in valleys at the Seven Springs (the source of the River Churn) and around Compton Abdale. The difference in level between the dry and the stream valleys shows the extent to which the latter have lowered their beds since the former were deprived of the supply of water that originally fed them.

Sequence of Events[2]

As far as can be ascertained from the scanty evidence afforded by the Drift deposits, the following is the sequence of events during Pleistocene times.

The oldest drift is the Cheltenham Sand and Gravel. It has been shown in the memoir descriptive of the Moreton in Marsh area that this is older than the local boulder-clay, and was laid down during an earlier cold period, the ice of which did not reach this district. During this cold period material from the Trias of the Midlands (*i.e.* the sand in the Cheltenham Sand and Gravel) was brought into the district *via* the Vale of Evesham. This was followed (though perhaps not immediately) by an invasion by ice, which left patches or spreads of boulder-clay.

After the retreat of the ice, the district came under the influence of a more or less prolonged period of less severe glacial conditions during which extensive ice- or snow-caps covered the high ground in winter but thawed in summer.[3] The water from such thaws was responsible for (1) the removal of the spreads of boulder-clay, leaving only remnants protected in fissures or pockets in the lime-stones, (2) the formation of certain spreads of gravel at the foot of the dip-slope which contain not only limestone pebbles but also

[1] 'Summary of Progress' for 1927 (*Mem. Geol. Surv.*), 1928, pt. ii, p. 70 and 'The Country around Moreton in Marsh' (*Mem. Geol. Surv.*), 1929, pp. 134, 135.

[2] By H. G. Dines.

[3] The possibility of a complete recrudescence of cold conditions must not be overlooked.

a comparatively high proportion of northern erratics from the Boulder Clay (Higher Gravels of the Plain), and (3) the formation of a number of small, but often deep, valleys which are now permanently dry.

After this semi-cold period many of the valleys became dry and only those supplied by springs were able to lower their floors—leaving the now-dry glacial valleys as hanging valleys along their sides, and draining on to the Oxford Clay plain to contribute limestone pebbles to the spreads of gravel at the foot of the dip-slope (Lower Gravels of the Plain, in which erratics are rare).

Later the Oxford Clay plain appears to have become submerged, or subjected to periodical inundations, which resulted in the formation of the Older Alluvium, covering both solid and drift deposits on the plain.

Throughout the Recent Period tranquil conditions have prevailed, resulting in normal corrasion of river valleys with the accompanying deposition of valley drifts.

The sequence of deposits in relation to the sequence of events may be tabulated as follows :—

Recent	Alluvium Terraced River Gravels	Cutting down of present river valleys, resulting in the dry valleys becoming hanging valleys.
Probably belonging to close of Glacial Period	Older Alluvium Lower Gravels of the Plain	
Probably all Glacial	Higher Gravels of the Plain Boulder Clay Cheltenham Sand and Gravel	Formation of the now dry valleys

The Geology of Cirencester : Explanation of Plate VII

The sketch-map on the folder facing this page is given to show the distribution of the alluvium and associated gravel, clay and limestone in Cirencester and the immediate vicinity. The boundary lines are approximate and except those of the alluvium and that between the Kemble Beds and Forest Marble proper, which have been inserted by Mr. Dines, have been transferred from the Old Series Geological Survey Map.

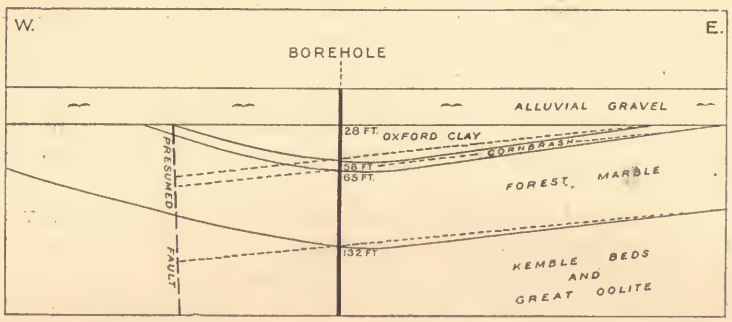

Fig. 4.—*Diagrammatic section east-and-west through the Lewis Lane Borehole showing two alternative possibilities of structure. Not to Scale.*

According to Mr. Dines : " West of the town there are two patches of Forest Marble separated by the fault which passes under the lake in Cirencester Park. The more southerly occupies the top of a fairly flat piece of country which has a gentle tilt to the south, apparently due to the regional dip of the beds. The more northerly, however, dips to the east, the gentle slope that faces the entrance gates to Cirencester Park at Cecily Hill being the dip-slope of the beds. East of the town practically the whole area consists of Forest Marble, apparently dipping gently to the west, forming the eastern limb of a

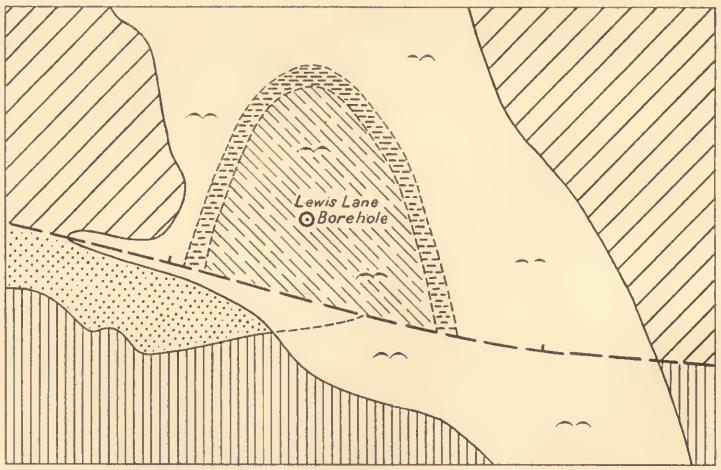

Fig. 5.—*Sketch to show the possible arrangement of the Oxford Clay and Cornbrash beneath the alluvium of the River Churn, assuming no faulting as shown in the sketch-map (Plate VII). The shading of the outcrops corresponds with that of the sketch-map.*

SKETCH MAP OF THE ENVIRONS OF CIRENCESTER

Scale 1/4 Mile
0 200 400 600 800 Yds.

INDEX

SUPERFICIAL DEPOSITS

ALLUVIUM
The alluvial deposits in the valley of the River Churn, consist mainly of limestone gravel, nearly 30 ft thick.

SURFACE OUTCROPS

CORNBRASH
Brashy limestone

FOREST MARBLE
Alternating layers of grey clay & hard limestone

KEMBLE BEDS
False-bedded oolitic limestone

GREAT OOLITE
White limestone division, massive, even-bedded oolitic limestone.

CONCEALED OUTCROPS
Conjectural position of formations proved in the Lewis Lane boring.

OXFORD CLAY, with KELLAWAYS ROCK

CORNBRASH

Faults, tick on the downthrow side.

400 ft. Contour.

(27) P.S.21648/120 T. 750. 9/32. G.S.O. CIRE.

gentle synclinal fold, of which the western limb is the Forest Marble north of 'The Lake Fault.' It is apparently in the bottom of this synclinal trough that the Oxford Clay and Cornbrash occur under the town, as proved by the borings at the Lewis Lane Pumping Station of the Urban District Council's Waterworks."

The syncline may be faulted or unfaulted as shown in Fig. 4. The sketch-map is based on the assumption that faulting is present, but Fig. 5 shows the probable arrangement of the concealed outcrops of the Cornbrash and Oxford Clay if faulting is absent. The scanty evidence in favour of the faulting is as follows :

1.—Assuming a syncline, a uniform dip on each side of the axis would bring the Cornbrash outside the Alluvium on the west. The beds must therefore dip gently eastward as far as the Alluvium and then plunge more steeply, unless faulted.

2.—The borehole at Barton Mill enters Kemble Beds immediately below the gravel. That at The Beeches shows the Forest Marble to be thick. This, together with the fact that Forest Marble covers a wide area east of the Churn and only a small one west of it, seems to indicate that the beds are generally lower to the east.

3.—Faults in the area to the north, for which surface-evidence has been obtained, if continued southward would give rise to the underground structure represented on the sketch-map.

CHAPTER VIII

ECONOMIC GEOLOGY

Agriculture

By Prof. J. A. Hanley, A.R.C.S., Ph.D.

The area covered by this memoir consists almost entirely of strongly undulating country of ' limestone ' soils. For generations it has been concerned chiefly with corn-growing and the breeding of live-stock, mainly sheep, the land being that so frequently referred to by agriculturists as ' sheep and corn land.' The proportion of permanent grass on the cultivated land is low and confined mainly to the valleys. There are also considerable areas of poor and almost uncultivated heath land at higher altitudes where the soil is too thin or stony for the plough.

Although useful streams water the main valleys and give rise in places to irrigated meadows, known as water-meadows, the area is, from the farming point of view, badly watered.

In recent years, and especially since 1921, the gradually falling prices of corn have resulted in an increase in the area under grass, and one now sees here and there a herd of milch cows where formerly sheep would have been the only live-stock. Again, herds of pigs folded out of doors must be regarded as somewhat of an innovation in this district. ' Grass ' sheep are also replacing sheep of the Down breeds formerly fed mostly on arable land crops.

The old four-course rotation with its modifications, including catch crops for sheep, is no longer so strictly adhered to as was formerly considered necessary. The old Cotswold breed of sheep is now represented in the area by one or two flocks only.

Crops

The grass land, except in the valleys, is of a ' dry calcareous ' type. Where cultivation has been meagre and manuring scanty the commonest feature of the grass hillsides is the tor grass (*Brachypodium pinnatum*). Like many other stoloniferous grasses it tends to develop in patches, roughly circular, to the exclusion of practically every other species. It is a coarse grass disliked by stock, and is grazed only during a period of drought when very little else is available. Another common and unpalatable grass on these limy soils is the erect brome. Leguminous plants

occur freely and only need the encouragement derived from applications of phosphate (soluble forms answer best under these dry conditions) to spread rapidly and improve the grazing. At the same time under the same treatment the spreading of tor grass is checked.

On the more retentive clays of the Forest Marble a better herbage with a good sprinkling of perennial rye grass can be developed by generous treatment.

The whole area, however, is subject to drought, not because of a low rainfall but on account of intense evaporation during the spring and summer months. Sun and drying winds repeatedly play havoc with pastures grazed too bare in spring or early summer. Perhaps nowhere else in the country is this effect more marked. For the same reason it is not too easy to establish new pastures on these soils. In a favourable season they start well, but the drying out sooner or later seriously reduces the proportion of the more useful species, leaving gaps to be filled in mainly by ' rosette ' weeds like plantains and daisies; the calcareous soil encourages a flora very unrestricted as to species.

The difficulty in obtaining good permanent grass on these soils has been felt throughout the area in recent years when farmers have tried to reduce the acreage of arable land. The difficulties of maintaining good ' milk ' pastures have also been widely felt by those who have tried to replace the growing of corn by milk production.

On the arable land sheep and corn have for generations been the main standby, and the four-course rotation with catch crops for sheep-feed and long sainfoin leys have served that purpose well.

Many sainfoin leys can still be found and when in flower give brilliant spashes of colour to the Cotteswold Hills. Either green, or as hay, sainfoin is a sheep and lamb food much valued by the Cotteswold shepherd. Unfortunately during the war the area under Common Sainfoin leys was much reduced, and subsequently the larger but less persistent Giant Sainfoin was used. Many of the old and persistent strains of the valuable Common Sainfoin have been almost lost after having been kept on the same farms for generations. The same remarks apply to some of the old strains of Red Clover.

The root crops consist mainly of mangolds and turnips and kale (for sheep folding); very few potatoes are grown.

The soils suit barley but there is a considerable acreage of wheat, and beans are grown on the heavier soils.

Seed of both red and white clover is harvested.

There are practically no fruit or market garden crops except in the villages. Neither climate nor soil is particularly suitable for them.

Soils

The topography is one of widely rolling hills intersected by fairly deep and steep-sided valleys, so that many narrow outcrops on the hillsides are of little importance agriculturally. The most important and extensive outcrops are those of the Great Oolite, Forest Marble and Cornbrash and perhaps the Inferior Oolite.

Soil mapping in this country is still in its infancy, and no attempt has yet been made to make a systematic survey of the soils of this area. That soil classification must be based on the characteristics of the soil ' profile ' is now generally recognized. This ' profile '—or vertical section through the upper layers of soil to the parent material—usually shows well defined ' horizons ' due to zones of leaching and zones of accumulation. Changes of colour due to migration of oxides of iron and humus, or changed relations of silica to sesquioxides, give the clues to weathering changes produced by climate, vegetation, etc., which may fundamentally alter the properties of a soil for agricultural purposes.

The soils of the area would probably be regarded internationally as either ' Brown Earth '[1] or Brown Forest Soils.

The following are some of the soil descriptions, including profiles from typical outcrops. No attempt has been made to classify them or place them in named series :—

(1) Locality : Gilbert's Grave, Aston Blank (p. 29).
Parent Material : *Inferior Oolite.* (Soil may be affected by the thin Roundhill Clay bed found locally between the Inferior Oolite and Chipping Norton Limestone).
Mode of Formation : Mainly sedentary.
Topography : Elevated. Rolling hills.
Drainage : Free.
Profile : 0-6 in. dark, reddish-brown light loam ; rather stony ; calcareous.
6 in. + disintegrated rock.
(See table on p. 102).

Grassland herbage covers the ground thinly, and consists chiefly of fescues, erect brome, dwarf thistle, eyebright, hop clover, bird's foot trefoil, burnet, bedstraw, and a few rosette weeds. There are also traces of golden oat grass and cocksfoot, whilst the land shows a tendency to revert to thorn bushes.

(2) Locality : On the Freestone Series of the Inferior Oolite near Cowley (ninth milestone from Cirencester to Cheltenham).
Profile : 0-9 in. reddish-brown medium loam, stony, calcareous.
9 in. + very calcareous rubble.

On old woodland cleared of timber a few years ago and with free draining soil the following plants were found :—thorns, brambles, thistles, wild mint, potentilla, wild strawberry, eyebright, bugle, bird's foot trefoil, sedges, mouse-ear hawkbit, silver weed, geranium, burnet, red and white clover, wild thyme, ragwort, violet, harebell, speedwell, meadow vetchling, scabious, bedstraw, bent grass, tall oat, fescue, cocksfoot.

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[1] Ramann, E., 'The Evolution and Classification of Soils,' transl. by C. L. Whittles; 8vo, Cambridge, 1928.

The area is grazed every year and this is affecting the natural transition to bush and heath.

(3) Locality : Leygore, near Northleach.
Parent Material : *Fullers' Earth.*
Mode of Formation : Sedentary.
Topography : Elevated. Slope (a V outcrop along both sides of a valley).
Drainage : Impeded.
Profile : 0-4 in. dark brown heavy loam.
4-10 in. yellow-brown clay.
10 in. + yellow clay mottled orange and green with some limy concretions.

In this and other arable districts the Fullers' Earth can be traced by the very dark-brown colour of the surface soil contrasting with the warmer tints of the soils from limestone rocks.

The herbage of the grass land contains clover, eyebright, restharrow, dwarf thistle, sedges, trefoil, some rosette weeds, crested dogstail, tor grass (*Brachypodium*) and thorns.

The Fullers' Earth determines outbreaks of springs which here and there give rise to badly water-logged land growing rushes, etc.

(4) Locality : Upper Slaughter.
Parent Material : *Great Oolite* (Stonesfield Slate).
Mode of Formation : Sedentary.
Topography : Elevated. Gentle slope.
Drainage : Free.
Profile : 0-8 in. brown medium loam.
8-10 in. yellow-brown coarse sand with clay.
14 in. + oolitic 'slates.'

(5) Locality : S.E. of Little Rissington (p. 38).
Parent Material : *Chipping Norton Limestone* ; perhaps trace of Upper Estuarine Clay in surface soil.
Mode of Formation : Mainly sedentary.
Topography : Elevated. Fairly flat.
Drainage : Free.
Profile : 0-10 in. reddish-brown heavy loam.
10 in. + disintegrated rock.

The Chipping Norton Limestone appears gritty, as though it contains a considerable proportion of quartz grains, but an analysis of stone from this quarry by Mr. A. W. Ling, Bristol University, gives :—

Calcium carbonate	90.2%
Oxides of iron and alumina	2.7%
Siliceous matter	7.1%

(6) Locality : New Barn, Northleach (p. 53).
Parent Material : *Great Oolite* (White Limestone).
Mode of Formation : Mainly sedentary.
Topography : Elevated. Fairly flat.
Drainage : Free.
Profiles : (a) 0-9 in. dark-brown medium loam ; calcareous.
9 in. + marly disintegrated rock.
(b) 0-9 in. dark-brown medium loam, calcareous.
9 in.-2 ft. yellow-white marl (local).
2 ft. + hard oolitic limestone (seen to 6 ft).

(7) Locality : Hampnett Glebe, Northleach (p. 53).
Profile (a deep phase) :
0-9 in. brown medium loam ; slightly acid.
9-20 in. reddish-brown medium loam.
20 in. + (seen to 42 in.) reddish-brown heavy loam, mottled orange and green.

This land has been the subject of a good deal of inquiry, since it differs agriculturally from that described under (6) with profiles (a) and (b). It occurs in patches in many localities, and although deeper gives more trouble under cultivation than (6), (a) and (b). The surface has a pronouncedly lighter colour and is less calcareous, in fact it is generally slightly acid.[1]

A further series of profiles on this type of land was obtained as follows :—

(8) Locality : Shipton Down.
Parent Material : *Great Oolite* ?
Mode of Formation : Mainly sedentary.
Topography : Elevated. Gentle slope.
Drainage : Free.
Profile : (a) 0-12 in. brown medium loam.
12-18 in. slightly redder medium loam.
18-20 in. reddish-brown heavy loam.
20 in + rock.
(b) 0-9 in. brown light loam.
9-12 in. brown medium loam.
12 in. + rock.
(c) 0-9 in. brown light loam
9-21 in. lighter-brown medium loam } no stones at
21-25 in. reddish-brown heavy loam } these horizons.
25 in. + rock

It is uncertain whether this variability in depth of soil and material is due to ' pipes ' in the rock or to infillings or deposits of drift.

Near Sherborne Park the White Limestone underlying a brashy marly soil contains pipes and pockets of chocolate-coloured clay (see table p.103 ; also p. 53) which would appear to be sedentary on and derived from the limestone.

(9) Locality : Cirencester.
Parent Material : *Forest Marble.*
Mode of Formation : Sedentary.
Topography : Elevated. Flat.
Profile : 0-8 in. reddish-brown medium loam, calcareous.
8 in. + yellow-brown heavy loam to clay with flaggy limestone. The limestone beds and the clay vary greatly in thickness and persistency.

(10) In the quarry south of Ampney Park, Ampney Crucis, the face showed 5 ft. of Cornbrash, on 5 ft. of stiff Forest Marble clay, over about 20 ft. (seen) of solid Forest Marble limestone (p. 80).

Occasionally, for example near Eastleach village, the Forest Marble gives rise to soils which are greyer in colour than is usual in this area.

(11) Locality : Broadmoor, Coln St. Aldwyn (p. 74).
Parent Material : *Forest Marble.*
Mode of Formation : Sedentary.
Topography : Slightly elevated. Flat.
Drainage : Impeded.
Profile : 0-10 in. dark-brown heavy loam ; calcareous.
10-18 in. yellow-brown clay ; calcareous.
18-24 in. yellow-orange to brown mottled clay ; very calcareous.
24 in. + rock.

This soil is cold and heavy. The grass land is set up in ridge and furrow. Big open fields in a somewhat exposed situation have been run together and grazed with cattle and sheep. North Country (White faced) × Oxford Down ewes are mated with a Suffolk ram to produce lambs which are later folded on roots.

[1] Most deep phases (over 10 in.) of limestone and chalk soils lose their calcium carbonate by leaching and become acid.

The herbage contains crested dogstail, sweet vernal, fescues, cocksfoot, ryegrass and plenty of white clover; there are also some rosette weeds and thistles. A typical dwarf calcareous clay herbage.

The Forest Marble clay often affects the Cornbrash land overlying it by holding up drainage water.

(12) Locality: N.E. of Fairford.
Parent Material: *Cornbrash.*
Mode of Formation: Sedentary.
Topography: Flat.
Drainage: Free in surface soil. Impeded locally.
Profile: 9 in. chocolate-brown medium loam.
9 in.+ flaggy rock.

At 4 ft. the water is held up by Forest Marble clay, and land adjoining seems to be rather cold and late.

East of Cirencester the Swindon road follows a belt of Cornbrash land—medium to heavy loam in texture—which is generally good and fertile. Most of it is now devoted to mixed arable and dairy farming.

Gravels overlie the margin of the Oxford Clay along the southern boundary of this area. Most of the villages are on these gravels, and get their water from them. Springs usually break out along the edges of the gravels and give rise to wet grass land with rushes, etc. At a pit near Meysey Hampton (p. 86) the soil description is as follows:—

(13) Parent Material: *Higher Gravels of the Plain*—mostly local limestone; few pebbles of northern material.
Mode of Formation: Sedentary.
Topography: Slightly elevated, slightly undulating.
Drainage: Free.
Profile: 0-9 in. dark-brown gravelly medium loam.
9-15 in. lighter-brown, very pebbly medium loam; pebbles small—zones irregular.
15 in. + gravel.

The herbage of the grass land is weedy—chiefly rosette weeds. The turf is very open and consists of clover, fescues, bentgrass, cocksfoot, a little ryegrass and patches of yarrow.

(14) At Lechlade Station (p. 86) on arable land the soil description is practically the same, except that the colour is lighter in the top horizon and the second horizon is less noticeable. There is a considerable area of this arable land. It is very subject to drought but crops well in wet seasons. Roots, including mangels, barley, ryegrass and clovers, often with sainfoin and wheat, are the usual crops.

The Valley soils range from colluvial soils in dry or almost dry valleys to the alluvial clay and peaty soils of wet areas subject to flooding.

(15) Locality: Eastleach Turville, gravel pit near (p. 89).
Parent Material: *Alluvial sand and gravel* with probably some Forest Marble clay and Great Oolite material.
Mode of Formation: Colluvial, downwash and sediment.
Topography: Lower slopes and bottom of narrow valley.
Drainage: Usually free, subject to flooding.
Profile: 0-5 in. dark-brown silty medium loam.
5-19 in. brown gravelly heavy loam.
19-24 in. white gravel containing re-deposited calcium carbonate.
24 in. + sandy calcareous gravel with some siliceous sand.

The top soil is apparently alluvium deposited over the sand and gravel.

The herbage contains red and white clover, trefoil, crested dogstail, cocksfoot, tall oat grass, Yorkshire fog, fescues, bedstraw, burnet and scabious.

(16) Locality : Taynton, Burford.
Parent Material : *River Alluvium.*
Mode of Formation : Partly sedentary, partly flood deposits.
Topography : Low-lying and flat (river level).
Drainage : Impeded.
Profile : 0-6 in. dark-brown medium loam, slightly mottled.
6-12 in. lighter-brown medium loam, mottled.
12-20 in. light-brown calcareous heavy loam.
20 in. + (seen to 42 in.) yellow-brown clay, mottled.
No stones were noticed in this alluvium.

The underlying beds are Upper or Middle Lias clay, but no blue clay was seen down to 42 in. The River Windrush floods these meadows with sediment-holding water from the clays of the Vale of Bourton.

The herbage is variable according to level but the flora clearly indicates wet conditions.

(17) Locality : Bourton Meadows, near Netherton (p. 89).
Parent Material : *River Alluvium.*
Mode of Formation : Partly sedentary, partly flood deposits.
Topography : Low and flat.
Drainage : Impeded.
Profile : 0-4 in. black peaty silt.
4-30 in. yellow-brown clay, mottled and wet.
30-36 in. wet peat.
36 in. + yellow-brown clay.

This soil is flooded by the River Dikler. The herbage contains red and white clover, bent grass, fescues, tussock grass (*Aira caespitosa*), rushes, sedges, silver weed, bugle and buttercup.

There are occasional patches of gravel in this alluvium.

(18) Locality : Churn valley, near North Cerney (footnote, p. 88).
Parent Material : *Alluvium.*
Mode of Formation : Partly sedentary, partly flood deposit.
Topography : Low and flat.
Profile : 0-4 in. brown silty medium loam.
4-6 in. light-brown medium loam.
6-20 in. light-brown heavy loam.
20 in. + light-brown heavy loam, mottled brown and black, becoming very mottled at greater depths.

This profile occurred on a ' pane ' of a water-meadow. The herbage contains a good mixture of grasses and clovers with many buttercups and a few rosette weeds.

This water-meadow is typical of a considerable area of irrigated grass land in the Churn valley. The herbage has been studied by Prof. R. G. Stapledon and is described in some of the publications of the Royal Agricultural College, Cirencester.

From the analyses given in the table it would appear that all soils on the Great Oolite Series have much in common. The mechanical analyses are very similar, but they differ from those of the Inferior Oolite and Fullers' Earth in the proportions of fine sand to clay. In this respect, however, the Chipping Norton Limestone falls into line with the Great Oolite (White Limestone division). The Forest Marble ' Clay ' and Cornbrash also can be grouped with the Great Oolite Series.

The Inferior Oolite, including the Freestone Series, the Sand and Gravels fringing the Oxford Clay (No. 14) and the Taynton Alluvium (No. 16), are characterized by their high content of calcium carbonate.

The pH values indicate a group of soils which are practically all alkaline in reaction. Only the deeper phases of the Great Oolite soils show an acid reaction, and this is perhaps partly responsible for the trouble experienced in their cultivation.

The analyses so far carried out do not help a great deal in solving the question as to the extent to which drift or residues from clay beds are responsible for the rather heavy soils overlying the limestones. The greatest thickness of soil occurred on Nos. 7 and 8. No. 8 agrees closely in mechanical analysis with No. 6, a typical ' White Limestone ' soil, but No. 7 and the good soil (Hampnett Glebe) from the same field as No. 7 contain less clay and more sand. Neither No. 7 nor No. 8 contain any recognizable stones or pebbles through the whole 42 in. of profile examined. No. 7 might well be the surface (perhaps 20 yards across) of a ' pipe,' but No. 8 appears to cover a much larger area amounting to several acres.

More systematic survey work on the soils, involving mechanical and chemical examination of horizons other than the top (A) horizon, will be necessary before the interesting types in the Cotteswolds can be classified and mapped.

Building Stone

The freestones, that is, the stone that can be cut by saw without splitting, and other limestones in the Oolites of the district have been worked in the past for building purposes in many quarries, large and small, but at the present time only two are ' in work '— the larger and more important one being the Fosse or Farmington Stone Quarry, near Northleach; and the smaller, Smith's Cross Quarry, south-west of Elkstone.

In the Inferior Oolite Series, Lower Freestone has been quarried for building purposes west of Coberley; in The Pitch Quarry close to the Cheltenham-Oxford road some 350 yards south-south-west of Shipton Solers, near Andoversford; and as ' Yellow Stone ' at the Bourton Hill Quarries north-west of Clapton from which stone for the building of the greater part of Bourton on the Water was obtained. There are many localities in the drainage-basin of the Churn above Colesborne, as well as places in the Coln valley above Withington (as is evident from a study of the railway-cuttings) and in the vicinity of the Bourton Hill Quarries, where good freestone is readily obtainable.

In the Great Oolite Series building stone has been drawn from practically all horizons, but the best freestone has been obtained from the Taynton Stone subdivision. The houses, barns, etc., on the Great Oolite tract have practically all been built of the local Great Oolite.

Table showing Mechanical and Chemical Analyses
The analyses were carried out by A. W. Ling, M.Sc.,

Soil No	1	2	3	5	6	—	7
Description ...	Inf. Oolite	Inf. Oolite, Free-stone series	Fullers' Earth	Chipping Norton Lime-stone	Great Oolite	Great Oolite	Great Oolite
Cultivation	grass	felled wood-land	grass	arable	arable	arable	arable
Approx. pH. ...	—	8.0	—	7.4	—	7.2	6.2
Coarse Sand ...	0.6	0.2	0.4	0.1	0.1	0.2	0.2
Fine Sand	8.2	14.5	13.7	31.9	29.9	32.2	39.7
Silt	10.3	12.4	14.9	21.2	13.0	21.6	24.3
Clay	34.4	34.6	49.1	35.4	35.6	34.6	27.1
Loss by Solution ...	5.4	3.3	1.8	2.0	2.3	1.9	1.0
Loss on Ignition ...	20.0	11.3	16.6	7.9	7.7	8.7	6.2
Moisture	6.8	6.0	9.9	4.7	6.2	5.4	4.1
Carbonate of Lime	23.1	25.5	2.1	1.3	8.0	1.2	none
Stones	47.3	19.6	—	4.3	8.0	2.7	none
Available Potash ...	0.013	0.007	0.009	0.007	0.004	0.007	0.007
Available Phosphoric Acid ...	0.004	0.003	0.006	0.006	0.003	0.013	0.005
Locality	Gilbert's Grave, Aston Blank	Near Cowley, Cirencester-Cheltenham road	Leygore, Nr. Northleach	S.E. of Little Rissington	New Barn, Northleach	Hampnett Glebe, Northleach (Good land)	Hampnett Glebe, Northleach (Inferior land)

of Soils in the area covered by this Memoir.
Chief Advisory Agricultural Chemist, University of Bristol.

8	—	10	11	—	14	16	17	18
Great Oolite	Clay from pocket in Gt. Oolite lime-stone	Forest Marble, un-weath-ered clay 4ft. down	Forest Marble	Corn-brash	Sand and gravel	Allu-vium	Allu-vium	Allu-vium
arable	—	—	grass	arable	arable	grass	grass	grass
6.2	7.6	—	7.4	>7.6	>7.6	7.4	>7.6	—
0.1	0.3	—	0.5	0.9	3.0	—	1.4	—
32.7	27.1	30.7	17.2	33.3	27.1	13.2	8.4	11.2
17.4	16.9	22.6	21.9	17.2	12.7	16.8	18.1	18.3
33.9	47.6	36.9	46.4	34.3	22.3	32.0	39.5	42.1
1.7	0.7	1.5	1.8	2.3	2.7	3.8	4.1	4.8
12.7	6.4	3.5	9.7	8.8	7.6	12.9	26.7	16.0
6.6	6.8	3.7	6.3	4.5	3.3	6.2	9.1	7.2
none	0.9	5.5	1.1	2.8	26.2	20.6	6.0	8.4
none	none	none	1.1	6.7	24.1	none	2.0	—
0.005	0.005	0.006	0.012	0.007	0.008	0.006	0.003	0.006
0.007	0.001	0.046	0.005	0.004	0.060	0.001	0.010	0.004
Shipton Down (Inferior land)	Sherborne Park, Northleach	Ampney Crucis	Coln St. Aldwyn	Far Hill, near Fairford	Lechlade Station	Taynton, Burford	Bourton Meadows, Netherton	Churn valley, Nr. Cerney

The Ragstone portion of the Stonesfield Slate Series passes locally in the Northleach area into a very good freestone which is actively worked at the Farmington Stone Quarries, or former Fosse Quarry, close to the Fosse Way about 2 miles north-east of Northleach. According to the manager the reason why this is the only quarry working on this bed of limestone is because (1) the beds are massive, more so than usual in the district, blocks as large as 6 ft. by 4 ft. by 2½ ft. being removable intact, and (2) the stone is ' white ' and of uniform colour throughout. The products of the quarry are building material faced and cut according to specification. The different kinds produced are quoins, chimney ashlars (blocks for building chimney stacks), coping stones, window frames and mullions, fire-places, and fancy work such as bird baths, pedestals and carvings for garden ornaments. The full depth of the quarry is 20 ft., making 15 to 17 ft. of workable stone. The stone below the bottom of the pit is said to be hard and too brittle to saw.

The stone worked at Smith's Cross Quarry, south-west of Elkstone (p. 46) also belongs to a lower division of the Great Oolite Series. The upper 5 ft. consists of comparatively thinly-bedded limestones locally known as ' Pennant ' ; the lower 12 ft., of massive, false-bedded, shelly oolite constituting the ' Weatherstone.' According to a quarryman the Pennant is used for ' dry ' walls (nearly all those in the neighbourhood having been built of it), but is unsuitable for houses as it is not weather resisting, " biding and going with the weather." In wet weather it sweats and the damp comes through the plaster. On the other hand the Weatherstone is weather resisting and once the ' sap ' is out of the stone moisture is not again absorbed. It is said to have been used for most of the old churches of the neighbourhood. The stone is got by picking holes or grooves (with a ' jad ') in which wedges are inserted to separate the block from its bed. Chimneys, copings, mullions and steps are the usual articles made from the stone, which is shaped with an axe. Wickwar War Memorial was constructed of Weatherstone from this quarry.

Very fair building stone, approaching freestone in character, has been obtained locally from the White Limestone, but this subdivision—with its hard, white, ' flinty ' limestones—is as a rule more useful as a source of road-metal and lime.

The Taynton Stone is the freestone, *par excellence*, of the district. It has been extensively worked in the past at Windrush ; in Sherborne Park for the mansion ; at Little Barrington, and on Taynton (or Tainton) Downs. At the first two localities it was ' mined.' " The stone [of Taynton Downs] " wrote Woodward, " has attained a considerable reputation. Numerous old pits are to be found, like the ' hills and hollows ' of other famous stone districts. . . ."[1] " The remarkable false-bedded character of the . . . stone, may have led to the opinion that when used for build-

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 306.

ing it is best surbedded, that is, set ' edgewise, contrary to the posture it had in the quarry.'

" The best stone is of a dark brown colour, and this occurs sometimes at the base and sometimes at the top. There is no reason to believe that all the good stone has been exhausted at this locality. . . . Building-blocks and crests for ridging are shaped; and formerly cisterns, troughs, coping-stones, etc., were produced.

" As remarked by Professor Hull: ' The freestone . . . has furnished the stone for some of the oldest buildings at Oxford, viz., those of the 12th, 13th, and 14th centuries, and is still in good preservation; the mouldings being sharper and less weathered than of some buildings of 17th and 18th centuries, which are cut out of blocks from Heddington Hill quarries, near Oxford.'[1] Thus it has been used in the ancient parts of the Cathedral (Christ Church), in Merton College and Chapel, also in Blenheim Palace.'"[2] Sherborne Park is built of Taynton Stone of a pleasing yellowish tint, that was quarried in the park.

The Kemble Beds, where of Great Oolite facies as in the south-western part of the district at and near Cirencester, furnish some useful building stone. Many of the old houses in the town are built of it and it is now quarried off Chesterton Lane. The Royal Agricultural College, it is understood, is built of stone (Kemble Beds) that was obtained from a quarry—now an earth-covered depression—adjacent to the Cirencester-Stroud road some 250 yards north-west of the College. Certain parts of the Kemble Beds, where the subdivision is mainly of Forest Marble facies, have been quarried for building stone, but as a rule this facies is more productive of slabs and heavy stone-tiles (see p. 106).

Tile-stones

In the Cotteswolds to the north of that part dealt with in this memoir, most of the tile-stones, and the best, have been and still are obtained from the ' slate ' bed at or near the base of the Stonesfield Slate Series. Large numbers have also been procured from the Chipping Norton Limestone, but these are smaller, heavier in proportion to their size, and of more irregular thickness than the Stonesfield or Cotteswold ' slates.'

In the present district most of the tile-stones have been obtained from the Forest Marble and the Forest Marble facies of the Kemble Beds; but a fair number has been got from the Stonesfield Slate ' slate ' bed.

The localities at which the Stonesfield ' slates ' have been obtained in this district are alongside the main road about 2 miles west by north from the Puesdown Inn, near Hazleton; at Chedworth; at Rendcomb; and at Pen Hill, near Colesborne (see p. 40).

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[1] ' The Geology of the Country around Cheltenham ' (*Mem. Geol. Surv.*), 1857, p. 58.
[2] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 479.

It would appear that a bed yielding tile-stones is present at or near the base of the Great Oolite throughout the Great Oolite tract, but the impression that the writer has gained—for there are no pits now ' in work '—is that, except in the vicinities of Shipton, Hazleton, Salperton and Turkdean, they do not approach the quality of the ' Cotswold tile-stones ' of the Naunton and Eyford districts. In the vicinities of the villages named the beds are disturbed by numerous faults; the ' slate ' bed may pitch in various directions, end off abruptly against a fault, or continue beneath a rapidly increasing thickness of overburden. This calls for careful preliminary investigation if a new tile-stone undertaking is in contemplation.

For reasons given elsewhere (p. 72) it is difficult to say whether the tile-stones or ' planking ' at certain localities occur in the Forest Marble (Wychwood Beds) or the Forest Marble facies of the Kemble Beds, but the information available points to the best tile-stones occurring amidst the more clayey deposits of the Forest Marble and the ' planking ' in very obliquely-bedded Kemble Beds.

At the present time only two pits from which tile-stones are obtained are 'in work ' : the one lies a quarter of a mile west of Betty's Grave, about half a mile north of Poulton ; the other near Knoll Barn to the north of Coln St. Aldwyn, but the tile-stones from the latter ' pit ' are the thicker, are more of the nature of ' planking,' and come from presumed Kemble Beds. Localities at which good tile-stones have been obtained in the past are as follows :—between Moor's Farm and Upper Moor's Barn to the north-east of Coln St. Aldwyn; Cadmoor, near Barnsley; and Poulton (' Poulton Slates '). It is said that if the tile-stones are taken from the quarry and used at once (*i.e.*, in the ' green ' state) they are less durable than those that have weathered for a time; therefore, for effecting repairs and tiling new houses, second-hand tile-stones are now mostly used. The Royal Agricultural College, Cirencester, and Barnsley village are tiled with local tile-stones.

The tile-stones are from $\frac{3}{4}$ to 1 in. thick and, unlike the Stonesfield or ' Cotswold ' ' slates,' do not require splitting by the action of frost—or ' frosting ' as it is termed. H. B. Woodward observed : " They occur as thin flags or leaves of limestone (or occasionally calcareous sandstone), often arranged in oblique bands separated by horizontal layers of clay and shale. All that is necessary is to dress them to the required shape. They resist frost and are considered to be more durable than the Stonesfield Slate, but they are heavier and coarser."[1]

The large slabs or stone planks (' planking ') are 3-4 ft. in length, $1\frac{1}{2}$-4 ft. in width, and 3-5 in. in thickness and have been

[1] ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 485. See also J. Lycett, *Quart. Journ. Geol. Soc.*, vol. iv, 1848, p. 185 ; ' The Cotteswold Hills,' 1857, p. 106.

extensively used in the past for floors of kitchens, courts and yards, for garden-edgings and stiles, as rough coping for walls, or as pitching for stables. They are suitable for crazy-paving.[1]

Bricks, Tiles and Pottery

At the present time (1930) no brick and tile works are 'in work.' In the past bricks were made of (1) Lower Lias clay at Oulan's pit, near Lilley Brook, Charlton Kings (see p. 8); (2) Upper Lias clay at Colesborne (p. 12) and Sherborne (p. 12); (3) Great Oolite clays near Holwell (p. 51), and (4) Forest Marble clays at Stratton, near Cirencester.

Sand and Gravel

True siliceous sand suitable for building and other purposes is found in this district only in the north-western corner—near Charlton Kings Station and to the west: the 'sand' found locally associated with the River or Oolite Gravel in the river valleys in the hill country and on the Oxford Clay tract in the south-eastern corner is, as a rule, 'oolite sand'—de-cemented oolite. The deposit that is called Cotteswold Sands in this district, where present, consists of an admixture of fine sand and much clay, and nowhere has the sand been sufficiently freed of clay by percolating waters to produce a noteworthy thickness of 'loose' sand.

Well worn Oolite Gravel is to be met with in the valley of the Churn near Cirencester (*e.g.* at The Barton); in that of the Coln at many localities between Fosse Bridge and Fairford (p. 86); in that of the Leach just above Eastleach Turville; and near Fairford and Lechlade stations.

Lime

Limestone is of widespread occurrence in the district—in the Inferior Oolite, Great Oolite, Forest Marble and Cornbrash.

No Inferior Oolite rock is now worked for lime-burning. The stone worked by the Leckhampton Stone Quarries, Ltd., at their Leckhampton Quarries just outside the present district to the west, until the company went into liquidation in 1926, was Lower Freestone. This limestone gives the best results: a sample from The Pitch Quarry, close to the Cheltenham-Oxford road, situated about half a mile west-south-west of Shipton, near Andoversford, contained 96 per cent calcium carbonate (see p. 108). Limestone belonging to this subdivision could be opened up at numerous localities in the Coln valley and to the west thereof, but to the east its lithic structure changes somewhat. In the eastern part of

[1] See J. Bravender in Hunt's Mineral Statistics for 1858 (*Mem. Geol. Surv.*), pt. 2 (1860), p. 155.

the district the Clypeus Grit is the most prominently-developed Inferior Oolite subdivision and is displayed in numerous quarries. A sample of this rock from Gilbert's Grave Quarry, No. 1, close to the Fosse Way, one mile south-east by south of Aston Blank, gave 92.3 per cent of calcium carbonate.

The White Limestone of the Great Oolite has been quarried for lime-burning at many points, but in 1930 the only kilns in use were (1) at the quarry alongside the Ermin Street near the fourteenth milestone from Gloucester, and (2) at The Fosse Lime and Limestone Works at Foss Cross. At these works there is a large kiln, after the design of Messrs. Mignon, Roland and Bourgoin of Paris, with an output capacity of 400 tons per week. There is also a Barron Dreadnought Crusher and Mill used for making poultry grit, for grinding Ground Oxide of Lime, and for pulverising Carbonate of Lime mostly for agricultural purposes, with an output capacity of 100 tons per week, and one Schuteless Hydrator with a K.B. pulveriser for the manufacture of Hydrated Lime, with an output capacity of 210 tons per week.[1] The following analysis is by Rowland H. Ellis, F.I.C., F.C.S., and was made in 1928 :—

Analysis of Lump Lime from the Works of The Fosse Lime and Limestone Co., Ltd.

	Per cent
Silica	3.01
Lime (as CaO)	92.90
Magnesia	0.40
Sulphates	0.65
Carbon	0.02
Oxide of iron	2.02
Oxide of alumina	1.00
	100.00

Analyses of Forest Marble and Cornbrash limestones from the quarry near the second milestone from Cirencester, south of Ampney Park, are given below. At the present time neither formation is worked in the district for lime-burning, but in the past Forest Marble was extracted at the quarry south of Ampney Park for this purpose.

Analyses of certain Jurassic limestones from the Cirencester District by Cecil Cooke Duncan, F.I.C., F.C.S., County Analyst, Worcestershire

	Results per cent				
	1	2	3	4	5
Moisture	0.31	0.28	0.12	0.03	0.2
Silica (SiO_2)	5.35	2.93	2.16	1.66	0.82
Iron and aluminium oxides (Fe_2O_3 and Al_2O_3)	1.86	3.14	1.09	1.44	0.4
Calcium carbonate ($CaCO_3$)	92.3	93.48	96.0	96.5	96.88
Alkalies, etc.	0.18	0.17	0.63	0.37	1.7

[1] For a detailed account of these works see L. Richardson, *Proc. Cotteswold Nat. F.C.*, vol. xxiii, pt. 3 for 1929 (1930), pp. 269-272.

1. Clypeus Grit. Gilbert's Grave Quarry—No. 1, close to the Fosse Way, one mile S.E. by S. of Aston Blank.
2. Cornbrash. Quarry south of Ampney Park, near Cirencester.
3. Lower Freestone. The Pitch Quarry, about ½ mile W.S.W. of Shipton, near Andoversford.
4. Forest Marble. Quarry south of Ampney Park, near Cirencester.
5. Great Oolite White Limestone. Quarry alongside the Ermin Street near the fourteenth milestone from Gloucester.

Road Metal

The main roads of the district are metalled with imported stone and tar, but many of the by-roads continue to be maintained with local stone.

All the Ragstone beds of the Inferior Oolite have been worked at one time or another for road-metal: at the present time the Upper Trigonia Grit and Notgrove Freestone are the subdivisions most actively worked in the area west of the Coln valley; the Clypeus Grit in the country between the Coln valley and the Vale of Bourton; and the Clypeus Grit and Chipping Norton Limestone in the Rissington district, where Inferior Oolite beds beneath the Clypeus Grit are absent. At Newtown, Turkdean, Upper Freestone (harder than usual), and at Hill Barn, Clapton, a bed of ? Oolite Marl and the top portion of the Lower Freestone (both harder than usual) are worked for road-metal.

In the parts where the Stonesfield Slate Series is typically developed and crops out, as, for example, in the vicinities of Turkdean, Hazleton, and Compton Abdale, the hard limestone beds in the Series provide stone suitable for road-metal and pitching. The hard, white, 'flinty' limestones in the White Limestone subdivision have been extensively quarried for road-metal and for lime-burning. The presence of these hard beds is readily ascertainable, for the white rubble to which they give rise on the arable fields is distinctive. Parts of the Kemble Beds, in both their Great Oolite and Forest Marble facies, are very suitable and have been worked in many localities for metalling the local roads and for 'dry' walling.

Water Supply

Full particulars of the springs, wells, and piped supplies of this district—with the exception of those in ten parishes in Oxfordshire (discussed below)—are given in 'The Wells and Springs of Gloucestershire' (*Mem. Geol. Surv.*, 1929). It will suffice therefore to deal briefly with the subject here.

The three chief horizons at which springs issue or water is met with are at or near the base of (1) the Inferior Oolite, (2) the Great

Oolite, and (3) the Cornbrash. Useful springs are thrown out locally by clayey beds in the Great Oolite, and small supplies are obtained from wells in the Forest Marble. In Cirencester many houses still have private wells in the Churn-side gravel bed and Lechlade and Little Faringdon obtain their supplies from gravel.

Lower Lias.—Lower Lias is present in the Chelt valley and Vale of Bourton and, as is well known, is not a formation from which satisfactory supplies of water can be obtained—even for private dwellings with small requirements.

Middle Lias.—Middle Lias also is present in the Chelt valley and in the lower slopes of the hills that almost enclose the Vale of Bourton. It also occurs near Taynton, Oxfordshire. In the Chelt valley there is locally some seepage from the base of the Sandy Beds : wells sunk into the basal portion of these beds would doubtless collect small supplies. The Dowdeswell Reservoir of the Cheltenham Corporation, which impounds the head-waters of the Chelt, is on the uppermost beds of the Lower Lias and the Sandy Beds of the Middle Lias. Locally, small chalybeate springs issue from impersistent, ferruginous, impure limestone layers in the Sandy Beds, and when water is low in the reservoir their occurrence is more apparent. Practically nothing is known concerning the Middle Lias beds beneath the Marlstone in the Vale of Bourton and vicinity of Taynton : surface indications, however, point to their being more argillaceous. Small supplies, doubtless, could be obtained from wells sunk into the Marlstone.

Upper Lias and Inferior Oolite.—The Upper Lias clay is naturally not productive of supplies : its importance lies in its function of throwing out or holding up water that has worked through the superincumbent Cotteswold Sands (local traces) and Inferior Oolite. The top of the Upper Lias is indeed the horizon at which issue the principal springs in the district, many of which are drawn on for supplies. They are as follows :— Source of the River Chelt (small spring) ; sources of the Ullen Water, Lilley and Hilcott brooks ; Seven Springs, the source of the River Churn ; Wine's Well, Colesborne (piped to certain properties) ; ' Marsden Spring,' Rendcomb (water pumped to supply various properties, including Calmsden) ; ' Woodbridge Spring,' Withington ; Bobble Spring, Little Rissington ; Haycroft Springs, Sherborne (pumped to supply Oranges Farm, Ewepens Buildings, Woeful Lake Farm and the western part of Sherborne village) ; Windrush Mill Spring, Windrush (water pumped to various properties and to Sherborne Estate property in Aldsworth village), and ' Bittam Copse Springs,' in Farmington parish but close to the Sherborne parish boundary, which constitute the perennial source of the Sherborne Brook. Drilled tube wells that tap water held up by the Upper

Lias clay are situated in Ewepens, Cirencester Park (350 ft. deep), and Sheepbridge in the valley of the River Leach (166 ft. deep).

If a supply on the site were desired for a building on high ground on Inferior Oolite a deep well would be necessary; in most cases down to the Upper Lias clay. A well at Cold Comfort is 174 ft. deep and in August, 1920, contained 4 ft. of water. The Snowshill Clay, which is an important clay bed from a water-supply standpoint in the Inferior Oolite of the North Cotteswolds, occurs in the present district to the north of a line joining say Charlton Common, Chedworth, Northleach and Aston Blank; but is thin.

Fullers' Earth and Great Oolite.—The Fullers' Earth throws out many springs from the base of the Great Oolite. The following villages are on the basement beds of the Great Oolite and/or the Fullers' Earth, and are mainly dependent on springs thrown out from the base of the former :— Aston Blank (piped supply from 'Whitefurlong Spring'); Bagendon; Baunton (piped supply which also serves an extensive district to the east and south-east); Bibury (Bibury Spring, etc. Bibury Spring supplies The Court, etc., and Kilkenny in the Leach valley); Chedworth; Coln Rogers; Coln St. Dennis; Compton Abdale ('Crocodile Spring'); Daglingworth, Duntisbourne Abbots; Duntisbourne Rouse; Elkstone; Eastington; Hampnett; Hazleton; North Cerney (water pumped from strong spring at Perrott's Brook to Nordown, Cerney Downs, etc.); Northleach (piped supply from the 'New Spring' near 'The Wellings.' Water is pumped from 'The Wellings' to supply certain of Lord Sherborne's properties in Farmington and Eastington parishes); Shipton Oliffe ('Well Head'); Turkdean; Winson ('Winson Spring,' supplies village, Arlington and Barnsley); Winstone, and Yanworth. Both Birdlip and Colesborne (part) have piped supplies from springs thrown out by the Fullers' Earth—the former from 'Ridge Well,' the latter from one high up on Pen Hill. The 'Arnold Springs' in Lodge Park, near Sherborne, supply Lodge Park.

In the main mass of the Great Oolite there are several layers of marly clay, mostly impersistent (such as beds 14 and 21 in the Stony Furlong railway-cutting, near Chedworth) but increasing in number in the upper part toward the north-eastern end of the district. Springs thrown out by such layers are those at Lousehill and Calcott Peak Farm (Coln St. Dennis); at Kingsellhill, near Ablington (used for piped supply); in the valley north of Aldsworth up to Woeful Lake Farm; and in Rangehill Copse, three-quarters of a mile south of Windrush. Cirencester Urban District Council, Coates, and the Hatherop Estate obtain supplies from boreholes, a well, and borehole, respectively, tapping water in the Great Oolite held up by the subjacent Fullers' Earth.

The dip of the fissured Great Oolite and of the succeeding mainly impervious Forest Marble is greater than the slope of the country. In consequence, the Great Oolite crops out at a higher elevation than the succeeding Forest Marble. Valleys in the Great Oolite which, when continued, notch the succeeding but lower lying Forest Marble have rising in them locally, as in Ampney Park, important overflow springs. Such sites would be the best at which to sink wells to obtain large supplies.

Forest Marble.—Barnsley village is on Forest Marble and until 1926 was dependent on shallow wells, the supplies in most of which were limited and inadequate in dry weather. In March, 1926, a piped supply from the reservoir on Barnsley Wold, fed by a ram from the Winson Spring, was laid on to taps in the village. Barnsley Park is supplied from a well and borehole (well, 100 ft.; borehole, 60 ft.).

Glebe Farm and part of the village of Ampney Crucis are supplied from the Ampney Springs in Ampney Park; Park Farm and Hillcott End respectively from a spring and wells (12 to 15 ft. deep) in Forest Marble; while good springs from the Forest Marble issue at Ampney Knowle (pumped to supply the house) and Ampney Riding.

Ampney St. Mary has shallow wells, but in Lower Field Lane there is a borehole from which part of Lower Field Farm (Gloucestershire County Council Small Holdings Committee) and a farm and public tap in Ashbrook are supplied. Ampney St. Peter is dependent on shallow wells, but Eastington House has a borehole about 140 ft. deep.

Coln St. Aldwyn, Hatherop, and Quenington are partly on the top beds of the Great Oolite and partly on the Forest Marble. Coln St. Aldwyn has a piped supply of filtered Coln water; Hatherop is supplied from a borehole (114 ft. deep,[1] through Valley Gravel, 11 ft.; Forest Marble, 3 ft.; Great Oolite, 55 ft. 7 in.; Fullers' Earth, 44 ft. 5 in.) in Hatherop Castle grounds; while Quenington draws partly on the Coln St. Aldwyn supply and partly on that of Hatherop.

Eastleach Turville is partly on the Forest Marble and partly on the Great Oolite; Eastleach Martin wholly on Great Oolite. The villages are mainly supplied by a piped service from a well said to tap a spring (rising from the top part of the Great Oolite) on the east bank of the River Leach between Eastleach Martin and the Rectory. There is a ' fountain ' near the brook in Eastleach Turville from which a copious supply of water is discharged except in dry weather, and some wells occur in the village. The Sheep-

[1] Woodward, H. B., ' Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 510.

bridge boring (166 ft. to Upper Lias clay, p. 34) is in this parish and supplies Manor Farm.

Cornbrash.—The village of Preston derives its supply from a borehole, 108 ft. deep, through Cornbrash and Forest Marble, possibly into the top beds of the Great Oolite.

Poulton village is mainly on Cornbrash, but partly on Forest Marble. It is supplied by wells, ' Poulton Spring,' and ' Poulton Water Supply.' The last was provided in 1906 for the mansion, the Poulton Priory Estate, and certain houses. It was purchased by the Cirencester Rural District Council in 1930. The source is a dug well, 150 ft. deep, and a bore, 42 ft. deep—total 192 ft.—through Forest Marble, Great Oolite and probably Fullers' Earth into Inferior Oolite.[1] It lies to the northward of Hartwell Farm in Meysey Hampton parish and is said to be capable of yielding 1,000,000 gallons per day in the driest summer. The water is raised by pumps operated by an oil engine, with a power windmill as an auxiliary, at the Hartwell Pumping Station and passed to the Hartwell Reservoir (capacity, 30,000 gallons) from which Poulton is supplied by gravitation, and to the Ready Token Reservoir (capacity, 10,000 gallons) from which Ready Token House, buildings and cottages, and a new house are supplied. In March, 1930, the consumption was approximately 45,000 gallons per week. Hardness in parts per 100,000: temporary, 20; permanent, 1.

Fairford is supplied partly by a spring thrown out from the base of the Cornbrash by the Forest Marble at Fairford Old Mill, and partly by wells. In the centre of Fairford the wells are from 9 to 10 ft. deep and the water-level fluctuates with that of the River Coln. Southrop is dependent on wells—some draw-wells, others fitted with pumps.

Oxford Clay—The small Oxford Clay tract is sparsely populated, but along its northern margin and in the vicinity of Little Faringdon its surface is overspread by Oolite Gravel from which Lechlade (by means of two boreholes, each 20 ft. deep, lined with tubes of 2-in. internal diameter) and Little Faringdon (p. 116) obtain their supplies.

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[1] In ' Wells and Springs of Gloucestershire ' (*Mem. Geol. Surv.*), 1930, p. 135, it is stated that this well and borehole went through ' Forest Marble and Great Oolite to Fullers' Earth.' As a borehole made in 1932 only a short distance away at Ready Token obtained no water from the Great Oolite, reached the Inferior Oolite at 235 ft. below the surface and struck an abundant supply in the Inferior Oolite it would appear likely that the Hartwell boring also reached the Inferior Oolite.

The Water Supply of Oxfordshire Villages in the District

Fifield.—This village has a gravitation supply belonging to the Chipping Norton Rural District Council from a spring issuing from the base of the Clypeus Grit, from which it is thrown out by the Upper Lias clay, in the hill-side between the village and Iccomb. The water is laid on to public taps and some houses.

Bruern.—The hill and valley country around Tangley Hall is in this parish, and in the valleys there are a number of springs the water of which finds its way into the Hazelford, or, as it is called lower down, Coombe Brook.

Taynton.—A gravitation supply from a spring, thrown out from the base of the Clypeus Grit by the Upper Lias clay, on the east bank of the Hazelford Brook three-eighths of a mile north by west of Taynton Church, supplies Taynton House, Church Cottages and the Mill, and also a tank fitted with a pump that serves the upper part of the village. A ' spout spring ' from another spring from the same geological horizon serves the lower part of the village. Springs from the same horizon as the preceding issue (1) on the left bank of the Coombe Brook at three-quarters of a mile north of Taynton Church, the water being raised by pumps operated by a waterwheel worked by the brook to Hill Barn and Taynton Barn ; and (2) 1 mile W.28°N. of Taynton Church, where there is a pump house but no piped supply to any building.

The boundary between Taynton and Fulbrook parishes between the Taynton-Burford road and the River Windrush lies just east of the limit of the map. Some 275 yds. east of the boundary in Fulbrook parish (Sheet 236) on the south side of the Taynton-Burford road (at about 343 ft. O.D.), is the Tadpole Spring, the source of supply of the Burford Waterworks Co., Ltd. The water issues from the base of the Inferior Oolite from which it is thrown out by the Upper Lias. At the spring there is a tank from which the water gravitates to the pumping station at Burford whence it is pumped to a reservoir at Tanner's Lane, Upton (capacity 120,000 gallons). The average daily quantity of water (hardness : temporary, 18.5° ; permanent, nil) obtained and supplied is 50,000 gallons, and a further 120,000 gallons a day could be obtained. The supply is constant.

Upton and Signet.—A portion of this parish comes in Sheet 235. Signet-hill Farm is supplied by the Burford Waterworks. It also has a well which, according to R. H. Tiddeman, is 60 ft. deep (" clay on very hard rock ")[1].

Westwell.—The village lies in a hollow in the Marly Beds and the lower part (in which there are marly layers) of the White Limestone subdivision of the Great Oolite. Previous to the provision of the supply mentioned below the bulk of the water used in the village was obtained from a spring thrown out by the Marly Beds or by a marly layer in the White Limestone.

Westwell Manor, farm buildings, Rectory, and six cottages in the village, Badger's Farm, and Down Farm and cottages, are supplied from two bore-holes with power windmills : one (No. 2) about half a mile south-west by south of Westwell, through rock, 104 ft. deep, yielding fully 9,000 gallons per day ; the other (No. 1), 1¼ miles west-south-west of Westwell and a quarter of a mile south-west by south of Down Farm, 400 ft. deep, yielding fully 3,000 gallons per day (see below). The water from both is pumped to a reservoir about half a mile south-west of Down Farm, from which it gravitates.

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[1] ' Water Supply of Oxfordshire ' (*Mem. Geol. Surv.*), 1910, p. 34.

Boreholes at Westwell

Made and particulars communicated by H. J. Godwin, Quenington, Cirencester, Glos. Surface level at No. 1 Borehole about 490 ft. O.D.

No. 1 Bore

		Thickness Ft.	Depth Ft.
1	White stone ...	25	25
2	Marl	4	29
3	Stone	4	33
4	Marl	1	34
5	Stone	9	43
6	Brown stone ...	3	46
7	Marl	2	48
8	Stone	14	62
9	Marl	1	63
10	Stone	6	69
11	Clay	1	70
12	Stone	10	80
13	Clay	6	86
14	White stone ...	12	98
15	Stone	14	112
16	Soft white stone	4	116
17	Stone	14	130
18	Clay	2	132
19	Brown stone ...	3	135
20	Marl	4	139
21	Stone	1	140
22	Clay and stone ...	15	155
23	Clay	7	162
24	Blue stone ...	42	204
25	Clay	2	206
26	Stone	5	211
27	Clay	189	400

No. 2 Bore

		Thickness Ft.	Depth Ft.
1	Soil	4	4
2	Marl	2	6
3	Stone	5	11
4	Marl	3	14
5	Brown stone ...	6	20
6	Marl	1	21
7	Stone	7	28
8	Marl	2	30
9	Stone and clay ...	11	41
10	Stone	7	48
11	Clay	1	49
12	Stone	2	51
13	Clay	1	52
14	White stone ...	33	85
15	Clay	1	86
16	Stone	7	93
17	Stone and clay ...	8	101
18	Clay	3	104

It is unfortunate that no more details are available than those given. In No. 1 Bore, bed 13 may be Upper Estuarine Clay; 14 and 15, Chipping Norton Limestone; 16 and 17, Clypeus Grit; and 24, Middle Lias; but the only thing that can be said for certain is that No. 1 Bore went down well into the Liassic clays.

Holwell.—Holwell village is on the clays and limestones of the lower portion of the Forest Marble. There is a pump, now disused, over a well near the church, and an old pump house near the pool, also near the church, from which barrels used to be filled. For some years, however, the village has had a piped supply (two village taps). The source (average daily quantity, 1,200 gallons) is a well (surface level approximately 440 ft. O.D.) about 90 ft. deep in Great Oolite,[1] in which the water stands at about 53 ft. below the surface,[2] at the disused brick and tile works three-fifths of a mile south-west by south of Holwell. The water is raised by pumps, operated by a power windmill, to a 5,000-gallon tank above the well.

Broadwell.—A portion of this parish, including Broadwell Grove, comes in Sheet 235 and is for the most part on Forest Marble. "Broadwell Grove house [on Forest Marble] is supplied from a spring from the Great Oolite

[1] Woodward, H. B., 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 305.
[2] Tiddeman, R. H., 'The Water Supply of Oxfordshire' (*Mem Geol. Surv.*), 1910, p. 52. Analysis of Water, p. 93.

[by the ford] at [Burford] Signet, 1½ miles distant. The water is pumped by a water-wheel to a tank in Aston Copse, thence gravitating to the house, cottages, keeper's lodge, &c. . . . Home Farm is supplied from a deep well about 80 feet deep."[1]

Broughton Poggs.—This village, mainly on the upper part of the Cornbrash, is dependent on numerous shallow wells from 9 to 12 ft. deep, the water in which is said to be adequate in quantity but doubtful in quality.[2]

Filkins.—Filkins village on Cornbrash is dependent on wells 9 to 12 ft. deep. Conditions are similar to those at Broughton Poggs.[3]

Little Faringdon.—The village and Langford House are supplied by a well about 20 ft. deep in River Gravel[4] (resting on Oxford Clay) alongside the River Leach at The Mill. The water level rises and falls with that in the pool below the millrace weir. The water is normally raised by a pump, operated by a waterwheel, to tanks at the top of Langford House and at Church Farm, but the village draws direct off the main. The supply is adequate and the quality satisfactory.

[1] Tiddeman, R. H., *Ibid.*, p. 33.
[2] ' Return as to Water Undertakings in England and Wales ' (*Local Gov. Bd.*), 1915, p. 496
[3] *Ibid.*, p. 497.
[4] Not ' in Cornbrash ' as stated in the ' Return,' p. 37.

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